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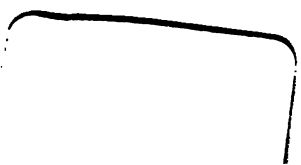
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THE HEALTH OF
THE CITY

HOLLIS GODFREY



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THE HEALTH OF THE CITY



THE HEALTH OF THE CITY

BY

HOLLIS GODFREY

AUTHOR OF "AN ELEMENTARY CHEMISTRY," ETC., ETC.

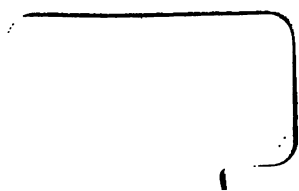


Review

BOSTON AND NEW YORK
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The Riverside Press Cambridge

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THE HEALTH OF THE CITY

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BY

HOLLIS GODFREY

AUTHOR OF "AN ELEMENTARY CHEMISTRY," ETC., ETC.



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BOSTON AND NEW YORK
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the difficulty of obtaining accurate generalizations from the statistics furnished by some American cities. For example, take the mortality of children under five years of age. The improvement in standards of living, combined with the work of some of the pure milk crusades, gives wholly different figures in 1910, in a selected group of cities, than 1900 furnished. A still greater obstacle to this special investigation is the lax methods employed by some municipalities in the recording of such matters as total births. In still other cases, as especially in the housing of the people, statistics have been gathered chiefly by private or semi-public associations, and no effective effort has been made by the public authorities to collect accurate information concerning existent conditions. I shall be glad at any time to know of changing conditions along any of the lines considered in this volume.

I have gained much of my data from books. I have gained more from personal visits of inspection made in the cities of this country and of Europe. I have gained most of all from men. During the course of the investigation I have talked and corresponded with men of every type, with street-cleaners, garbage men,

and market men, business men, doctors, and engineers, with any one, in short, who could shed any light on the things I wished to know. State and municipal authorities of England, Germany, and the United States, members of private and public associations engaged in various welfare movements, officials of corporations and universities, have given me assistance. It is impossible to name the many individuals who have done so much for me in so many ways. Here and now, I wish to offer my sincere appreciation of the many courtesies I have received.

The entire proof has been read from the standpoint of the economist by Professor Henry C. Metcalf of Tufts College, from the standpoint of the physician by Doctor Lincoln F. Sise, of Medford, Massachusetts, from the standpoint of the sanitary engineer by E. C. Howe of the Massachusetts Institute of Technology. The advice and assistance of each of these readers has been of great value.

I believe the names of the two men who have most influenced me in my scientific work, Professor John Sterling Kingsley of Tufts College and Professor William T. Sedgwick of the Massachusetts Institute of Technology,

should also appear in this Preface. I am glad to have this opportunity of declaring the debt I owe to them.

HOLLIS GODFREY,
*Head of the Department of Science,
Practical Arts High School.*

BOSTON, MASSACHUSETTS.

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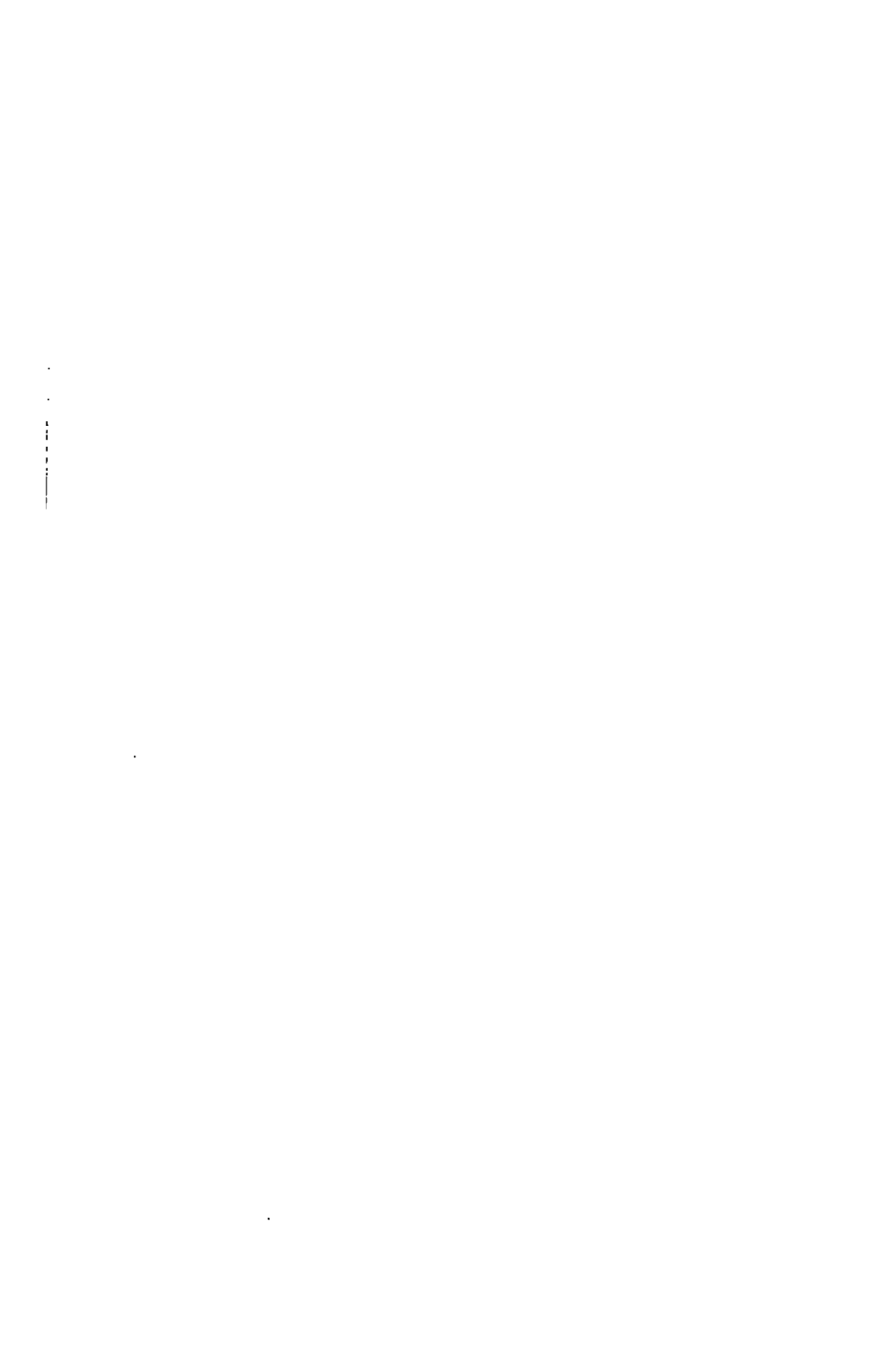
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THE HEALTH OF THE CITY



THE HEALTH OF THE CITY

I

AIR

WHEN, on that long-past burning August day, the wide-mouthed crater of Vesuvius poured down an overwhelming cloud on little Herculaneum and greater Pompeii, the daily life of rich and poor was choked out suddenly by that terrific burial in dust. As we escape from some fierce dust-storm in our cities, gasping and coughing with the load of dirt which has enveloped us, as we behold dark wreaths of heavy smoke pouring from soft-coal fires on every side, the thought must sometimes come that our communities to-day endure a peril far too much like that which, in that distant time, engulfed city and town about the Bay of Naples.

What does the air of the city hold? How does it differ from pure mountain air? Wherein lie its dangers? What can be found to remedy its perils? All these are questions whose

answer immediately concerns every dweller in community centres. We know, chemically speaking, that air in its normal state is composed chiefly of oxygen and nitrogen, approximately one fifth oxygen to four fifths nitrogen. Besides these it contains some carbon dioxide, a little water-vapor, a few inert elementary gases, and small traces of compounds formed from nitrogen. How much do we know of the burdens which the air carries, or of the wealth of life which the atmosphere holds? Day after day we go trudging to and fro along our various paths, at the bottom of a gaseous ocean which surrounds us, eating and sleeping, working with hand and brain, yet giving scarce a thought to the essential part which the air plays in our common life.

Of all the engines cunningly devised by man, not one can equal that masterpiece of construction, the engine of the human frame. To run that engine, air is the first necessity. Construct it how you will, the greater part of the energy which feeds a power-plant is lost before it reaches the applying machine. The body only has the power of using energy really economically and efficiently. Its food is its fuel. To be available, all the constituents of that food must

be burned, producing heat and power. For that burning the oxygen of the air is essential. The quality of the air we breathe must have an immediate effect upon the human frame.

Farther and farther outward stretch the high city walls of brick and stone, — engulfing tree and shrub, — laying bare grassy knoll and living green. Higher and higher rise the chimneys, and with their rise increases daily the great outpouring of solids, rushing into the air from the fuel burning in the fires below. Set a factory chimney in the midst of a grassy plain, or send forth huge volumes of hot gases from a steamer in mid-ocean, and the additions to the air are of but little consequence. The wind scatters them to infinite dilution. The air of the city rising from hundreds of chimneys and confining walls has no such chance. The task is too heavy for even the sweeping winds to accomplish.

With the outpouring of the city's chimneys has come a serious problem in these later days, a cloud which shadows all our cities, covering with its blackness wall and pavement, entering house and factory alike, — the city's smoke. Life in the soft-coal cities comes to be existence in a gray, blackened world. Whiteness

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of cloth, cleanliness of face or hands, becomes a shadowy hope, not a reality.

The reason for these conditions is by no means hard to find. Soft coal differs from hard coal most of all in this: when burned, its carbon, turning but in part to oxide, leaves a cloud of soft black soot, that carbon uncombined which soots the study-lamp or rises from the snuffed-out candle. The coating which such soot casts on the lining of the lungs is one of the hardships of the city-dweller, despite the fact that our breathing-organs possess a most extraordinary power of taking care of foreign bodies which invade their midst. Of all the particles that enter, no small portion returns, coughed back from the mouth or else ejected from the nose, where tiny filters held these solids as they entered. Those which persist and lodge in windpipe or in bronchial tubes find there a horde of soldiers placed to drive the invader back, the cilia. These sentinels are shaped like tiny fingers. They stand at this entrance to the body and swing unceasingly through life. As they swing, they beat invading solids, carried in the mucous stream backward and upward toward the mouth.

Besides the cilia, the phagocytes, those san-

tary engineers of the blood, stand ready to seize, encompass, and destroy harmful substances that may enter.

Yet through all these defenses solids can enter, and many do enter. Once in the lungs, they settle on the walls where passes out carbonic acid from the blood, where enters air carrying life-giving oxygen to the fires within. Where they fall, they clog the way. In city life, the fresh pink of a normal person's lung is streaked and spotted with black lines which chart the blocked-up roads where breath of life once entered, where burned-out wastes once passed. In reason this may do no serious harm, because of the tremendous space through which the boundary walls extend. The trouble is that we have long since passed the stage of reason in many of our cities. The flood pours on unceasingly. Every hour of every day the black smoke pours from the furnaces below. Scarcely a minute of the long year goes by without some addition to the total burden.

In smoky cities the proper ventilation of houses, one of the greatest essentials in stamping out tuberculosis, becomes more difficult. The doors and windows of the tenements are closed, and the stifled air within hastens dis-

ease and death. On humid days the smoke which fills the streets unites with the water-vapor of the air to form the fogs which overhang the city. Fogs can exist only when the gaseous water of the air is liquefied upon solid particles. The bits of carbon floating through the ways give such foundation, and the water condensing on them forms a mist. Probably without direct injurious effect, a fog depresses, renders resistance to disease more difficult, sets up a barrier to the cleansing, life-giving sun.

The pity is that most of the evils which come from smoke are preventable. Smoke-consumers exist which have shown their worth. Due care in running fires will do much. The fuel required under careful management to produce combustion which shall be practically smokeless need show but slight, if any, increase. It is a matter of community supervision, of laws rightly framed and fearlessly administered. Fortunately, inspection is no difficult matter. One city, for example, handles that problem by means of a chart holding six pictures of a chimney above a factory, the first of which shows the chimney with no smoke, the second with a light smoke issuing, the other four showing greater and blacker volumes. Th

first conditions are passable. The last are dangerous. The inspector takes a photograph of any questionable chimney and compares it with the standard pictures. The comparison tells the story. The factory is pronounced "passed," or the owner is warned to conform immediately to the regulations, under penalty of the law.

The West shows two cases which may aid the East in abatement of the smoke nuisance. In St. Paul, some years ago, the work was given over to the department of health, whose first act was to lay the following question before the local and national unions of steam engineers and firemen: "Can the smoke nuisance as it exists to-day be reasonably prevented without injury to trade and manufacturing interests?" This question was unanimously answered in the affirmative by the members of both unions. Notice was taken of all dubious cases, and fines were imposed when necessary: a minimum fine of twenty-five dollars for the first offense, doubled for each succeeding one. The work has been most successful, and besides an abatement of smoke, a saving of fuel is reported.

In Milwaukee an ordinance which has been in force for a considerable number of years,

has been successful in clearing the air of that city. About half the city at the time of a recent report used smoke-consuming devices; about one fourth used hard coal or smokeless fuel. The general condition of the city was admirable. So admirable, indeed, that the title of the ordinance passed by the Common Council is worth quoting in full as an epitome of what such an ordinance should be.

“An Ordinance declaring it to be a nuisance to cause or permit dense black smoke to be emitted from the chimneys or smoke-stacks of furnaces, boilers, heating, power or manufacturing plants, boats, vessels, tugs, dredges, stationary or locomotive engines, and creating the office of smoke-inspector, fixing his salary and prescribing his duties, and creating a board for the suppression of smoke.”

Close as is the relation between the products of combustion and the public health, there is a yet closer one between the other burden which the atmosphere carries — dust — and disease. For many centuries the world believed that air was a vehicle of disease, and many a historian of pestilential years told

of foul and heavy vapors which hung daily over doomed cities and seemed to carry death as they spread. From stage to stage passed the beliefs in the causation of epidemic disease, but with ever-recurring persistence they returned in one way or another to some belief in the transmission agency of the gases of the air. Only in that clarifying time when Schwann and Pasteur, Lister and Tyndall worked, was it made evident that the disease properties of the atmosphere came not from the air itself, but from the burden of living organisms which it bore. From that great demonstration came the germ theory of disease.

In the rush of modern scientific research the work done a generation ago is likely to be lost to sight. It is well worth a moment's pause, however, to recall the brilliant research by which John Tyndall, in 1868, proved the presence of organic matter in the air. Like many another experimenter, Tyndall found what he did not seek. He sought knowledge on the decomposition of vapors by light. He found the relation between dust and disease. The sunlight passing through a chink in the shutters reveals its path by the motes dancing in its ray. To obtain the results he wished, it was

necessary for Tyndall to remove all floating matter from the air of his tubes. He attempted to do this in various ways, finally passing his air over the flame of a lamp. To his surprise the floating matter disappeared. It had been burned by the flame. His mind instantly leaped to the conclusion that it was organic matter, though practically every scientist had hitherto believed that the floating matter of the air was wholly inorganic and non-combustible. Tyndall created a living world at a bound, the world wherein moves the living matter of the air. He pushed his inquiry farther. He placed a lamp in a beam of light. Strange wreaths of blackness rose, blacker, as he says, "than the blackest smoke ever seen issuing from the funnel of a steamer." Carrying the inquiry on, he tried the same experiment with red-hot iron, to preclude any possibility that the blackness might be smoke from a flame. "The same whirling masses of darkness rose,—smoke was out of the question." One conclusion remained. The darkness was that of stellar space, of the night which holds between the far-hung stars. The heat had burned the organic matter of the air, the inorganic had settled, no material substance

remained to reflect light. Dust was in part organic. Nay, more. Dust was made up of two parts: the inorganic, matter like the rolling sands of the sea; the organic, largely germ masses of living organisms, each infinitesimal, yet each unit complete in itself.

These micro-organisms of the air were soon proved capable of many things. Among other powers, they were proved to be carriers of disease. The surgeon's scalpel laid on a dusty shelf had time after time introduced the germs of evil into the wound it was meant to cure. An operation was a dread event where death was almost as likely as recovery. Lister's discovery of the possibilities of bacteriological cleanliness meant exclusion of germ-life from the surgeon's hand as well as from wound, instrument, and dressing. It brought life to thousands. Swiftly the new theory made its way. Germ-life which could cause disease existed in the atmosphere. Methods arose to combat the various forms of ill which it brought. Knowledge grew as to the specific germs of evil and their brothers of good.

The marvelous life of the earth, the teeming billions of micro-organisms which inhabit the soil, will be considered in a later chapter. It is

sufficient to recall here that by far the greater part of the earth's surface contains a vigorous microscopic life which serves many important purposes in the economy of nature. When earth is dried and driven by the wind about the streets, various types of micro-organisms rise with the dust, clinging to sand or splinter, or floating by themselves. Of these forms, the bacteria interest us the most. The great service which they perform lies in the power which many of them possess of taking worn out or exhausted organic material and turning it into harmless inorganic form. That service is turned to account in every modern sewage plant. The great injury which they may cause comes from a few forms in which lie the beginnings of disease. Growing with intense rapidity, these tiny plants, shaped like balls, rods, or spirals, spread wherever they may fall. Moist surfaces hold the germs, and besides the soil, they abound in manure and all decaying organic bodies, while those which find suitable homes in the human body multiply there with serious results. They appear in dust in billions piled on billions, when the dried earth, sweeping into the air with the varying impulse of the breeze, carries with it dried masses of bacteria.

The city street is a great centre of bacterial life. The concourse of the mart, the moving to and fro of many people, the constant throwing forth of human sputum, the dirt brought by the passing of many horses and domestic animals confined within a comparatively meagre space, all tend to furnish a constant supply of bacteria to the soil of the streets. When the soil has once been dried, the pounding of heavy wagons and the suction of the great wheels of motor-cars form a fine pulverized surface powder on the road surface, ready to rise in clouds with every wandering breeze. The healthiest period which exists in city air is that during or just after a rain or snow. Moisture brings the germ content of street air most teeming with bacterial life to figures low in the extreme. It is true that the great majority of the micro-organisms found in dust die after a brief exposure to air and sunshine. It is equally true that the traffic which fills the streets is constantly providing new hosts to take the places of the fallen.

To oppose the entry of any surviving germs stands that same chain of defenses which the respiratory tract raises against invading coal-dust, and, as well, that continuity

of armor which the body holds. Cased in the air-tight coverings of the skin without, lined with the barrier of the epithelia within, the human frame is well equipped by nature for the war against disease. Those coverings must be penetrated before disease can enter. A ragged sliver in the hand or foot often produces injuries far from proportional to its size. Why? because the poisoned arrow of the Malay, though swifter, carries no more toxic poison than may come from a splinter of the streets. The danger of the dust lies, beyond all else, in the fact that every dust-storm, bearing thousands of small sharp grains of sand, tiny splinters of wood, and bits of stone, is a flight of poisoned arrows driven against the body covering of the passer-by. The poison which they bear may or may not come from the dried organic matter of the street. It may be lying at the point of entrance where the germs growing in the warm moisture of the respiratory tract lurk within the body, like bandits beneath a fortress wall. In whatever way they come, it is most difficult for bacteria to pass through the body armor except when sharp particles such as those of dust make wounds or lesions in the inner walls. Once

such openings are made, dangerous micro-organisms are but too ready to avail themselves of the opportunity. When they are within, disease of major or minor type may show its presence.

Within the walls of dwelling, hall, or office-building, the direct dust-storm penetrates less easily, but only too often comes another danger from the difficulty of removing the fine cloud of dust which enters by every door and window from the streets, coating the furniture, hanging to curtain and rug, and clinging there with a persistence which renders many a city home a veritable storehouse of ancient micro-organic life. Especially is this true where hangings of cloth, upholstered furniture, and heavy carpets furnish excellent abiding-places for the germs. Few sanitary reforms have meant more than modern hardwood floors, light upholstered furniture, vacuum cleaning, and washable curtains.

One question must inevitably rise with any discussion of these points. "If such dangers exist about us in the city air which we all breathe, how can any escape?" It is easy to understand the freedom of individuals from specific contagion such as comes from impure

water or impure milk. Disease from such causes can strike only in isolated spots or separate communities. It is far more difficult to understand the immunity which is afforded the individual in the smoke and dust-laden air of thousands of American cities. Yet there is no question that great numbers show no signs of harm. Their vital resistance is so great as to make them triumphant over any form of disease. On the other hand, since there are thousands in any community who are susceptible to these attacks, it is the duty of the whole community to shield those thousands.

One germ found in dust needs especial mention. Tuberculosis, which may be classed among the dust diseases, ravages our country beyond all other plagues to-day. The consumptive sheds hundreds and thousands of living tubercle bacilli every time he sends forth sputum where it can mix with the dust of street or room. Once mixed with that dust, deposited on sand or other cutting particle, the poisoned weapon flies upward, ready to cut through and enter the body through the lesion formed in the lungs. And remember that every careless sufferer from tuberculosis is a

constant centre of infection. Grant that a large portion of the countless billions of tubercle bacilli die in light and air, grant that organized warfare against the evil is making a perceptible impression, and still the appalling roll of deaths from this cause will show how many infected mortals must walk the city streets and sleep in the city's rooms. In case after case we find in the lungs of perfectly healthy persons small tubercular lesions which have healed, showing that they were able to combat the poison when attacked. But how about the time of low resistance? How can the citizen tell when that time may come to him or to his family? The magnificent crusade against tuberculosis is doing much to convince the individual of the necessity of care against scattering contagion. The municipality can do one part toward the stamping out of the plague by a steady constant struggle to achieve the cleanest possible street. That ideal street will fail in its purpose, if its construction does not first of all prevent mechanical wounds to the passers-by through the agency of winged particles of harsh dust.

In the dirt of the assembly hall, of the theatre, of the hotel and the railway-car we find

conditions in which the difficulties which exist in the private house are fourfold multiplied. For hours the crowds of people in such places sit breathing the accumulated dust brought from the streets, which, rising from the floor, floats in clouds into the air and settles heavily on the antiquated plush still in high favor for such places. It is but a year or two ago that the newspapers considered briefly the dangers of that bacterial paradise, the Pullman sleeping-car. A brief spasm of remonstrance passed over the country, and disappeared as suddenly as it came. The peril from such sources was, however, recognized two decades ago, by more than one, and these words of Dr. Mitchell Prudden, concerning the presence of tuberculosis in such places, written almost as long ago, are no less true to-day: —

“Sleeping-cars and the staterooms of steamships and hotel bedrooms are almost always liable to contain infectious material, if they have been recently used by uncleanly consumptives or those ignorant of the danger of their expectoration. When the infectious nature of consumption becomes generally appreciated, hotels and transportation companies over long routes will be compelled to provide special

accommodations for such persons as are known to be thus affected."

Tuberculosis is but one of the contagious diseases which can be spread in this way, and its outdoor treatment is coming more and more to be recognized as consisting primarily of three things. First,—that the patient shall have an ample supply of good nourishing food. Second,—that the patient shall have an abundance of oxygen-laden air. Third,—that that air shall be as free as possible from all impurities. Climate and environment, important as they may be in many cases, both seem to be secondary to these requirements, and the spread of outdoor treatment from its original field of tuberculosis to that of other respiratory diseases, such as grippe and pneumonia, is along the same line.

First of all steps to be taken in freeing the city from dust, is the laying of proper pavements. Most of our present pavements are little better than those of common country roads piled high in time of drought with shifting sands. So long as dry and unstable earth caps the broken stone of many a city street, so long the dust-clouds will send many a patient to the doctors and the hospitals. The increasing use

of the automobile will inevitably make proper street-cleansing easier. To-day the roads torn up by the suction of the huge machines show little promise of advance, but the future should tell a different tale. Continuous pavements like those of asphalt are ideal, because of their smoothness for motor carriage, and when the horse passes from the city, streets so paved will be wholly available. There can be little doubt that the horse in time will have to go, as almost all the other wild and domestic beasts have disappeared from community centres. An anachronism in himself, the filth which follows him acts as a shelter for the micro-organisms of disease. With proper pavements, with the dirt of animals excluded, street-cleansing can be properly performed.

Within the house the vacuum-cleansing processes are sweeping out and completely removing from many a dwelling and public building the accumulated dust of years. In the vastly greater extension of such devices, in such increase of service as shall bring them within the constant use of every household, lies the great possibility here. City rooms will no longer be considered rightly ventilated by the dusty air of the sidewalk driven in by fans

blowing through open windows. Satisfactory air-filters will take their place, filters not left to the intermittent, semi-annual care of a janitor. One watchword of the model city of the future will be "Freedom from Dust."

As the centres of population become more and more crowded, as the distance between the workrooms and the bedrooms of the city grows greater, more of our population burrow beneath the earth on their daily passing to and fro. The condition of the air in the subways of the cities has been a moot point since their first establishment. Few subways have undergone more criticism in this respect than has the long winding tunnel which lies beneath New York. The trouble began with the first opening of the subway, while its stifling heat during the terrific summer of 1905 is a matter of painful memory to thousands. That heat was made yet more intolerable by the peculiar "subway smell." From those causes grave questions inevitably arose as to the healthfulness of the air within the subway. Those queries have now been answered in large part by an investigation made by Dr. George Soper, which considered temperature, humidity, odor, bacteria, and dust. The first two of these divisions, impor-

tant as they are, have comparatively little relation to our theme, but the last three are pertinent.

The belief in the injurious effects of the odor of the subway was a relic from the period when certain forms of illness were supposed to be directly connected with evil smells. With the exception of the ill effects which certain gaseous compounds of sulphur and carbon produce, there seems to be scarcely any ground for relating disease and evil odor. Constant exposure to any smell, be it bad or good, is likely to produce nervous irritation and exhaustion. On the great rose-farms of southern France, for example, the stranger, wandering among the fragrant fields, soon feels the same heavy headache which a persistently objectionable odor like that of a soap factory is likely to produce. A lowering of energy from any type of odor may put the individual into a condition to invite disease, but is little likely to be the direct cause of contagion. In the case of the subway, the odor came chiefly from the smell of the trap-rock employed in the stone ballast of the road-bed, mingled with lubricating oil and gear grease, and combined with occasional slight infusions of human odor. Dis-

agreeable as it might be when long inhaled, there was no reason to believe it dangerous.

The dust of the subway was quite another matter. It was very distinct from the dust of the streets, blacker, more clinging. As a horse-shoe magnet was brought near a heap of dust, the powdery mass sprang into magnetic curves. Following this line, two magnets of similar size were hung, one in the subway and one in an iron foundry; and the first showed clusters of black magnetic stuff far heavier than the second. Analysis after analysis showed almost half as much dust again by weight in the subway as was found outside. Over sixty per cent of that dust was iron. A passenger traveling for half an hour inhaled on an average some .42 of a milligram of the dust, a very appreciable amount, and received into his lungs a goodly number of iron missiles. Add to them the tuberculosis germs forever floating in the cars, and you have a very dangerous combination. The iron came from the wearing down of the brake-shoes on the wheels, and it is computed that the huge figure of twenty-five tons of iron and steel is ground into powder in the New York subway in the course of a month. Here is a type of dust too little regarded up

to the present time, which means much to the tuberculosis campaigns of the future.

The bacteria found in the subway were commonly less in number than those found outside, but amounted to the fairly high figure of some five hundred thousand per gram of dust, sometimes running as high as two million. The passenger waiting for the train, however, seems engaged in no more harmful occupation, so far as danger from the number of bacteria present is concerned, than he would be if he was waiting for a car on the street outside.

In summing up the situation, the engineer in charge states: "My own conclusion was that the general air (of the subway), although disagreeable was not actually harmful, except, possibly, for the presence of iron dust." Recent investigations of iron dust, particularly from the standpoint of those exposed to iron and steel dust, makes one believe that the word "possibly" in the quotation just made might well be stricken out.

One other point concerning subway air should be mentioned. The constant renewing of the atmosphere by the motion of the trains keeps the carbon dioxide in the tunnel so little more than that on the surface that, so far

as that index shows, few more harmful properties exist in the subway than in the streets.

Closely allied with the problems which the air of the city brings are the difficulties involved in the city's light. Despite the many theorists who have offered papers on the injurious effects of sunlight, we must believe from the long history of the race that we are made to be sun animals. The dwarfed frame of the poor cellar dweller, the stunted body of the child of the dark city room may be largely due to malnutrition, close air, and the other evil surroundings of the slum. There is small reason to think that lack of sunlight does not play its part in producing the total effect.

Over and over again in the succeeding chapters we shall be brought to realize that the germs of disease flourish in dirt and in darkness. Were there no other reason for letting in the light, the fact that the impulse to cleanliness comes with illumination would be enough. Take an apartment of five rooms, two of which have inside windows and three of which are the typical dark interior cells of so many tenement houses. The two light rooms will regularly show a large percentage

of improvement in cleanliness over the other three.

In no part of the house are the good effects of light regulation more perceptibly necessary than in the kitchen, where the materials which offer the greatest possibilities of decomposition and the best lodging-places for micro-organic life are concentrated. Recent investigations concerning the bacteria present in poorly washed dishes and in refuse spilled in the kitchen show the possibilities of germ-life inherent in dark kitchens. That room is the common living-room of the whole family in thousands of cases. The possibilities for the spread of disease which it offers are enormous.

Of no disease is the preceding statement truer than of tuberculosis, whose bacillus dies swiftly in cleanliness, light, and air. With this micro-organism, as with the other germs of disease, it is the dark room which furnishes the filth which holds the germ as well as the darkness which favors its growth. It is in the dark rooms of the slums that poverty forces the greatest amount of overcrowding. The air from such abodes may well be laden with the seed of the white plague. We know that men are affected by the combination of good

or bad air, space, food, and light. How heavily the factor of light may weigh in the total, we can hardly tell definitely as yet. It seems reasonable to believe that it bears no small part of the whole burden.

Germany has done far more to insure satisfactory lighting than has been even attempted in this country. In Saxony no building may be erected behind any other building for dwelling purposes unless a supply of light at an angle of at least 45° is secured for all the windows. At Ulm and Frankfort, when the municipality took up the work of housing, a supply of light was made one of the first requirements. To insure the carrying out of these needs, the width of streets, areas of front and rear gardens, and proximity of squares and boulevards were all taken into consideration. The "Zone" system of building, mentioned later, which limits the number of stories of houses in different districts of the town, has accomplished the same result in Cologne. There is more than one reason for such enactments.

One thing cannot be forgotten. The light furnished to houses must come from the sun. It is never sufficient to offer artificial light as illumination for any room of any habita-

tion. The shop or factory will furnish artificial light where it is needed far more readily than it can ever be supplied to the rooms of the great majority of homes. The employer knows that he must furnish light if his work is to be done. The woman in the home knows that every minute that her lights may run means money which must come from the weekly wage. She is unlikely to give sufficient light to any room where it is not furnished free by windows.

First of all necessities in the betterment of city air comes cleanliness outside and in. Crime, dirt, and disease are all rank growths of the dark. Light is a powerful factor of reform. No municipality is doing its duty to its citizens which neglects to enforce laws to provide light in every room of the habitations of men. How far some of our cities fail of that condition, we shall see later.

For the smoke nuisance, the dust evil, and the dark dwelling, the city can provide remedies. Laws passed, and enforced, requiring smoke-consumers and proper firing will do away with the smoke nuisance. Proper pavements, with good street-cleaning, will reduce germ-laden dust to a minimum. The city

which desires to give light to its inhabitants, has only to refuse to allow the occupancy of any new house whose rooms do not possess sufficient window space through which sunlight can pass at a proper angle.

It is all in the city's hands. Community life is apparently the inevitable sequence of our modern age. The fortunate who can, the intelligent who know, will turn more and more for their hours of recreation and of sleep to wide stretches of heath and hill, or to the comparative cleanliness of the suburbs. But for the thousands of the narrow streets, the cleansing of the city air is a necessity. To every pallid weary worker should come the rushing breath of purifying winds, the free and open air of heaven.

II

THE MILK-SUPPLY

IF the death angel, Azrael of the flaming sword, stood before the gates of the city crying, "Open ye! For every street within your portals must yield to me one babe in ten," what wailing and what lamentation would run quicker than thought through palace and through hovel! But decimation does not suffice the death angel to-day. Two babes of every ten die in our great cities, and the world, filled with the rush of our modern age, scarce gives a thought to this fearful winnowing.

Nor is such a statement in any way an exaggeration. There can be little doubt that of one thousand children born, the fifth year will find more than one fifth blotted out. And the majority of these have come from the narrow ways of the city. From under two hundred in those cities which do most, to over three hundred in those which do least, rises the five-year death roll. Many an empire-making struggle has passed with far less loss.

Read on the tattered banners of historic British regiments the golden scroll of battles, from Malplaquet to Pretoria. How few of them show any such list of slain as do these records of the tiny victims of disease in peace.

Study the rows of figures further, and certain definite facts stand forth in the light. June, July, and August are the months of greatest infant mortality. Diseases of the digestive system cause forty per cent of the deaths in many cities. Not only that, but deaths from other causes are rated as complicated by diseases of this class. No small number of these might well be added to the direct column wherein occur the greatest percentage of mortality. That points to one thing as a source of danger — the food-supply. Cow's milk is the exclusive food of a great majority of our children up to the time they are one year old. It is the chief food of practically all children from the age of one through the age of five. The inference is obvious.

Strange to say, the narrow street of the Azores, or the mountain village of northern Italy, feeds its children better than we can feed our own. Smelling to heaven though these little towns may be, with gutters running with

sewage, with walls and barns falling in dirty picturesque decay, their common milk-supply is superior to that furnished even to the better class of our American cities. Twice a day, morning and evening, the herdsman leads his goats through pathway, street, and rocky alley. Patiently the herd stands for its milking beside the clustering children, and the warm milk, fresh from the animal, goes directly to the child. The rising generation there gets pure, whole milk from a clean, healthy animal. Such milk is practically sterile, and if it be transferred to the consumer in that state, it is safe. But the danger from milk increases with every hour after it leaves the creature which produces it, unless precautions are taken to turn it over to the consumer in the same state in which it comes from the healthy animal. Therefore, since we can solve the problem in no such fashion as can the herdsman of the foreign streets, we must first understand the peculiar dangers which surround our city milk-supply and then find the means of overcoming them.

Our common necessities of life, such as air, water, and milk, are taken so much for granted, that many of their ordinary properties escape

our observation. The widespread course of milk, coming as it does to every family table, makes it a means for spreading disease, once pathogenic conditions have been introduced, second to no other medium, barring water. In one respect it is more dangerous than water, since a plague of typhoid or Asiatic cholera startles the community from its customary phlegm and causes immediate regulation of the single source of supply. But the death of children from stomach trouble or analogous disease makes no deep impression upon the people as a whole, and a hundred separate milkmen in a city are infinitely harder to regulate than is a common service of water. Other factors for comparison may be found in the inherent properties of the two liquids. The transparency of water causes its instant rejection when it bears visible sediment. The whiteness and opaqueness of milk serve as covering and shelter for insoluble substances. Dirt and filth, the carriers of disease, are easily hidden therein. A report from Germany, the home of systematic inspection, well shows the possibilities inherent here. Berlin, with its great system of vital statistics, reports that its inhabitants consume daily three hundred pounds of barnyard

refuse in their milk-supply. If that is true of Berlin, a city of extraordinary cleanliness, what must happen in our cities here?

Still more important than the mere carriage of dirt or filth stands the power of milk to give lodgment and nutrition to the bacterial hosts. These bodies are about us everywhere, lurking in the dust on the window-sill, floating in the sunshine, lying on the ground; they exist in such countless hordes that words like billion or quintillion utterly fail of significance when the number in an area of any size is to be considered. These invisible myriads of the air, moreover, increase with tremendous rapidity once they encounter favorable conditions for growth, such as moisture, warmth, and food. All these are furnished by milk. Raise barnyard dust near an open milk-pail, and the whirling masses which have been lying in the refuse of the barnyard floor pour down upon the liquid as the destroying Huns of Attila poured down upon Europe.

But it must not be thought that all of the bacteria are evil. Suppose we try to separate the sheep from the goats. Roughly speaking, we may say that three great classes of bacteria may be present in milk, the acid-producing

bacteria, the putrefactive bacteria, and the disease-germs proper. The souring of milk is an every-day phenomenon, and every housewife knows that high temperature sours milk and low temperature keeps it sweet. Translated into scientific terms, the souring of milk means that lactic acid bacteria, the bacteria of the first class, have been busily working on some of the constituents, and have changed a part of them over into lactic acid, which in turn has acidified the milk. This type of bacillus is commonly harmless, indeed it may have an absolutely beneficial effect; but the souring of the milk has been well called a placing of red lanterns to warn of danger, since the growth of these acidifying germs under ordinary conditions shows the growth of other types, which are productive of disease.

The putrefactive bacteria do not as a class belong in milk, but to be present must be introduced there from filth or outside refuse. This is the class of bacteria most dangerous to the child, since certain members of the group are the immediate cause of many of the serious digestive troubles of children. Dangerous, indeed, such troubles often are to adults, but far more dangerous when they assail the

delicate system of the child. Once entered into the intestines, they produce putrefaction there, with grave accompanying disturbances. Cholera infantum, for example, long recognized as an acute milk-poisoning, comes from these dangerous visitors, and its symptoms resemble those of poisoning by white arsenic, a violent gastro-intestinal irritant.

Putrefactive bacteria, moreover, breaking up the constituents of the milk, may produce dangerous end-products. These classes of bacteria by their growth change the composition of the milk, so that an infected or dirty milk, twenty-four hours old, may actually bring a poison to the child. And these infinitesimal bodies increase like wildfire. If two samples be taken, one from the milk of the night before, and the other from that of the morning of an examination, over one hundred thousand more bacteria per cubic centimetre will commonly be found to have sprung up over night in the uncooled evening's milk, than are found in the fresh supply.

The third class, the pathogenic or disease-germs proper, come in a way which is entirely preventable. They are the germs of contagious disease, the bacilli which cause typhoid, diph-

theria, and cholera, and they get into milk through milkers or handlers who are suffering from mild forms of disease, from persons who have been in contact with sufferers from such troubles, or else from deliberate or careless adulteration with a disease-infected water-supply.

Responsible as man may be for carelessness which allows the growth of dangerous bacteria, he is even more directly responsible when he deliberately adds water for purposes of gain, or skims off cream from milk which is to be sold as whole milk. In either case the percentage of fat is cut down, and a constituent is removed which is needed, not only for purposes of nutrition, but also for the energy which keeps our body-engine running. Thence comes a direct weakening of the resistant power and of the capacity of assimilation. The milk business, with its billions of gallons of milk, hundreds of millions of pounds of butter, and millions of pounds of cheese, is one of the great industries of the United States. With any such volume of business comes the tendency toward unrighteous gain. How great this evil is has been shown in St. Louis, where it was estimated in one year that over sixteen hundred

gallons of cream were removed each day, — a loss of \$900,000 a year to consumers, and one which bears most heavily upon the scanty purses of the poor. In New York the frauds committed by the milkmen were said some time ago to amount to about \$10,000 per day, a gain to a few individuals, which bears in its train two dangers, the transmission of disease and the lessening of bodily resistance because of diminished food-value.

There are, then, two factors to be considered in the control of milk. First, bacterial cleanliness, and second, the necessity for whole unadulterated milk. To fully recognize the necessity for proper bacterial conditions, we must trace the milk back to its source, consider the dairy farm, and what such a farm should be.

Dr. James K. Wardwell divides dairy farms as follows : —

“First, what might be called ‘model farms’ — places conducted as nearly as possible in an ideal manner and buying no milk from others. Second, good clean places — some old, some new — managed by careful men who are trying to do the best they can with what they have. Some of them buy from one or two neighbors

who are also careful and are watched pretty closely by the man to whom they sell. Third, all the rest."

No matter how thoroughly imbued city men may be with city life and city ways, nothing touches most of them more closely than does the thought of country life. Typical of all wholesome outdoor joys is the mind-picture of the old-fashioned barn. The wide doors swinging open to vistas of clover-scented meadow, the lofts laden with generous overhanging masses of hay, above which wheel the darting swallows, the cows and horses in their darkened stalls, and the broad bands of sunshine piercing the dusty windows, to broaden out into a full golden river before the open door, all give a setting for the imagination which completely fills the rural foreground of the average urban dweller. While that remains the conception of a dairy farm, the actual conditions are likely to be hidden completely from view. It is true that the old unswept barn where dust and refuse filled the air had evident difficulties, but it is also true that it had certain redeeming features. Our forefathers had a liking for "sightly spots," as they expressed it, and no one traversing the east to-day can fail to note


how often a great red or white barn crowns some noble eminence. Those heights meant good drainage, good air, and free ventilation. The milk produced there, once it left the barn, was the especial province of the good housewife, and the spotless purity of her cool milk-room with its border of shining milkpans was her pride and joy. Not only that, but the short time which intervened before the warm milk reached its users left comparatively little chance for injury. Then, indeed, the foaming draught from the healthy pasture-fed cows might well bear health and strength.

No such conditions exist to-day in the majority of dairy farms. The milk-supply of the city, if it comes from afar, must pass through hours of waiting by cross-road, by station, and in train, ere it reaches the urban terminal; and when it reaches the door it is likely to be anywhere from sixteen to forty hours old. Only when the greatest care has been taken in starting the milk clean, and keeping it throughout at a low temperature, can it arrive without accompanying millions of bacteria. If the milk comes from near at hand, the increasing value of real estate about a city only too often places the dairy farm in some damp,

undrained spot. In either case the doctrines of fresh air, cleanliness, and sunshine spread slowly through the consciousness of the hired milker, an employee not uncommonly taken from some batch of immigrants just entering upon their first occupation in a new land. So seldom is any cleansing attempted in some of these barns that every movement of the milkers plants the seeds of numerous colonies of bacteria. An almost historic experiment of Freeman's shows this clearly. Three culture-plates, shallow dishes containing jelly-like masses ready to give lodging and food to errant bacteria, were set for three minutes in separate places, one in the free open air, one just outside a barn, and the third inside, in front of a cow and beside a milk-pail when milking was going on. These jellies were afterward developed, that is, were put under conditions favorable to bacterial growth, and the first plate showed six, the second, one hundred and eleven, and the third, eighteen hundred, colonies of bacteria. No result could more strikingly illustrate the possibilities of the dirty barn. Not only the floor but the cow herself is an immediate provider of such bodies, for the sides and udders of the animal,

lying in the filth of the stall, carry many putrefactive germs. Then, too, those common carriers of disease, the swarming flies, may easily carry infection from a considerable distance.

The food of the herd must be good and ample if the milk produced is to be up to the standard. Where tower the walls of brewery or distillery the daily wayfarer may note streams of farm wagons which enter the big gates empty and come out full of dark spent grains. The farmer who buys those cheap grains is injuring the composition of his milk, and his wagon is bearing an improper food to the farm. That is only one of the dangers which come to the herd when greed of gain or ignorance holds sway instead of a wise progression. The milk of cows suffering from tuberculosis and other complaints is another example. Concerning this, one thing we may say. Bovine tuberculosis is probably transmissible to man. In any case, the secondary products of toxine reactions in tuberculous cows, or the impure milk which comes from any diseased cow, may fill the milk with injurious ingredients. But all these things are less likely to occur than is the ever-present trouble



of unclean milkers, unwashed dishes, and unswept floors. In cleanliness, in spotlessness, lies the great solution. One more point should be mentioned. Look out for sounds in the early morning hours which mean that milk is being bottled on the street in the wagon, instead of at the farm in the milk-house. The milk-house may well be in a far from perfect condition, but milk bottled there is far less liable to serious contamination than when it is taken from the farm in cans and bottled at the consumer's door. On the street the possibility of contamination from dust, flies, and dirty bottles rises to a practical certainty.

The number of proper dairy farms is growing year by year. Those breeze-swept sunny heights which called instinctively to the farmer of an older day, call because of their good drainage and ventilation to the modern farmer. His long, low barn, clean-swept, with floors where every form of filth may be easily and swiftly removed, his open stalls and stanchions, his separate hay-barn, all show thought, care, and cleanliness. On such a farm the milk-house is properly separate from the barn and deserves a word for itself. There come the clean-handed, white-clad milkers, with their

covered pails whose contents have been drawn from clean cows. No milker enters the milk-house, but each pours his milk from an outside passage directly into the aerator or cooler. This piece of apparatus takes the warm milk fresh from the cow, and cools it immediately to 40° or 50° F., passing it from a tank over a large expanse of cylindrical pipe, whose interior is cooled by coils through which flows running water. From the cooler, the milk is run direct into sterile bottles. These are capped and placed on ice, where they remain, both on the farm and in the wagon, until the consumer is reached. Such a farm has, as a matter of course, a pure and sufficient water-supply and clean and jointless milk-utensils.

With all the difficulties which bar the way, it must seem an Augean task to cleanse the city milk, to force the farmer to have proper conditions in his barn. Yet after all it is not so hard when one knows that there are definite ways to go about a cure, that dairy farms exist where pure milk is being produced, and that in some cities the milk-supply is excellent. Since it has been proved that a satisfactory milk-supply can be secured, the natural sequence is the arousing of the community to

such a point that it will require every farmer who supplies it to have a proper farm, every dealer to keep and deliver his milk whole and clean.

The necessity for those standards which oblige the milk to have a certain content of fat and solids, that is, to contain the amount of nutriment which should exist in milk from a healthy cow, is fairly recognized. The difficulty in this respect has come less from a lack of city ordinances than from the appointment of incompetent or untrustworthy officials; or else from insufficient appropriations, which too often keep good milk-officials from covering any reasonable portion of the supply, to say nothing of taking care of the whole. The automatic law, which will work without ample appropriations, though long sought, is yet to be found.

The newer standard, which requires that milk shall be free from injurious bacteria and germs, or that a fixed quantity of milk shall not contain more than a certain limited number of bacteria, is the one which chiefly needs our attention. For this standard a tiny mass of liquid, the cubic centimetre, about the thirtieth part of a liquid ounce, is taken. A small portion only can be used effectively, since even

here the number of bacteria present may range from a meagre hundred to a host of ten million. But counting the bacterial inhabitants in a cubic centimetre is quite as effective a way of telling the condition of the milk as counting the bacteria in a quart would be. It is known that the greater the number of bacteria present, the greater the chance for evil growths. We may, therefore, obtain a standard from the total number present, and decide that for practical purposes the purest milk is that milk which contains the smallest number of bacterial forms.

So the bacteriologist, bending over his microscope and culture-tube in the quiet laboratory, stands between death and the children. No unworthy follower of St. George, the dragon-fighter of old, is this follower of science, fighting the modern dragons of disease and death. To him may safely be left the task of guarding the city, provided we have a law which will require a proper limit to the number of bacteria present, and inspectors to enforce the law. In his laboratory the samples received from the wagons and the farm are each carefully labeled, properly diluted, and poured on plates which hold sterile solutions

calculated to give the best results in the way of bacterial growth when placed in warm, moist air. After a few hours under these conditions the plates begin to show small spots, which steadily grow larger and larger. These are the colonies from the individual micro-organisms, whose progeny have increased at the rate of hundreds, almost of thousands, an hour. Each colony means a single living organism at the start, and from the total of colonies the number of individuals present may be determined. Their kind also may be ascertained, be it harmless lactic-acid form, dangerous putrefactive type, or in many cases disease-germ direct. Such bacteriological care insures the safest and healthiest supply that a community can possibly obtain.

The safeguarding of the city's milk by sterilization and pasteurization has been so often considered that some reference to their action is essential. While heat up to 100° F. tends to increase bacteria rapidly, yet high temperature kills them, and the problem of the effect of temperature upon milk is no simple one. Whenever the housewife scalds her milk to keep it from souring, she employs sterilization. Her real object in the process is to kill the

lactic-acid bacteria and prevent them from doing their work. In fact, practically all the living organisms of milk are destroyed by keeping it at 212° , the boiling temperature, for ten minutes. But with this destruction come a series of changes which affect seriously the composition of the liquid. The gases, aromatics, and several of the watery constituents are lost, while some of the other constituents are modified. In consequence, the digestibility of the milk is affected, and serious intestinal illness has been attributed to a constant use of such milk by infants. The process is a somewhat difficult one to perform properly; moreover, the appearance and taste, as well as the composition, of the sterilized milk are injured. In consequence, comparatively little of it is used in American cities, though it is commonly found in continental Europe.

Pasteurization is the simple process of subjecting milk for twenty minutes to a temperature of not under 155° , not over 159° . This method, while it does not kill all bacteria, destroys the more dangerous of them, kills many putrefactive and disease-germs, and commonly reduces the number per cubic centimetre from thousands and tens of thousands of bacteria

to less than a hundred. Here is a possible safeguard for the individual family unable to obtain sanitary milk. The composition and appearance of the milk are less changed than by sterilization, yet decided results are obtained. The destruction of the souring bacteria is in itself no minor matter, since milk which either has turned, or is on the point of turning, may be given accidentally to infants, with serious digestive troubles as a result. But far more important than this is the fact that the destruction of the germs of tuberculosis, typhoid, and diphtheria is practically certain. Pasteurization is inexpensive, simple, and easy to perform, does not require complex apparatus, but does demand care. Yet any process which heats milk above blood heat can never be wholly satisfactory, and pasteurization is by no means perfect. Nevertheless, it surely seems wiser for the individual consumer to have recourse to it than to chance the use of milk from a questionable supply.

Commercial pasteurization, however, is a very different matter from individual pasteurization. On this subject we can hardly do better than to quote from Professor James O. Jordan of the Boston Board of Health, as follows:—

“Commercial pasteurization serves a purpose, but it is not true pasteurization. Undoubtedly nearly all of the souring bacteria are destroyed under this treatment, but the more deleterious bacteria are not killed, and these may produce harmful changes in the milk while it still appears sweet and palatable. Oftentimes this pasteurization means that filthy milk which would, under ordinary conditions, be unsalable, because of souring, is given a new lease of life and becomes a marketable commodity.”

Higher and higher loom the huge caravansaries where flock the city-dwellers. Greater and greater wax the numbers of hospitals and institutions. With the increase of centres where hundreds and thousands may be fed from a single source of supply, has come a different problem from that which meets the individual consumer. At least one record exists which tells how milk received pure may be kept pure, even when distributed in many different directions.

Down beyond the North End of Boston, where the harbor air first begins to hold its own against the city smells, lies the Floating Hospital, a noble philanthropy nobly carried

on. Some time ago, when a new hospital ship was equipped for its use, it was determined that pasteurization and sterilization should not be employed. That meant that bacterial growths must be practically excluded from the supply, for the cases which enter the hospital are largely those of children suffering from digestive disease. No satisfactory apparatus by which institutions could keep milk down to a minimum of bacteria had been evolved, and the search to find a way to accomplish this fell upon the director of the food-laboratory of the hospital, Mr. Frederic W. Howe. He took up the task, and designed a laboratory which sends out milk day by day with a smaller bacterial content than has been recorded from many institutions. The Boston Board of Health requires a standard of not more than five hundred thousand bacteria per cubic centimetre. The food-laboratory of the Floating Hospital sends out milk to all its wards with a bacterial content of from one to two hundred. How is this possible of accomplishment? It is done by means of a series of devices that insure absolute cleanliness in every process. That means a chance for the children, a decrease in infant mortality, which

is one of the noteworthy accomplishments of the day.

The cramped space of a ship leaves little room for useless experimentation, so the sunny laboratory is a *multum in parvo* of four small rooms, cut off from the rest of the hospital, and having communication by door only with the deck, by windows only with the corridors. The first room is the cleansing-room, where the nursing-bottles back from the wards are washed by motor-driven brushes in tanks filled with hot cleansing solutions. From there the bottles are taken to the great sterilizer, — a rack-lined, copper-floored room, where hundreds of bottles may be placed. The doors of the sterilizer are hermetically closed, and live steam, perhaps the greatest cleansing agent known, is turned on to fill every cranny of the room and of its contents. Then comes the modifier room, where the whole milk is modified to meet the needs of each individual patient. This room beyond the sterilizer is the essential part of the whole process. Any institutional apparatus must be of a sort to require a minimum of time and care with a maximum of efficiency. That is what is accomplished here. The modifier, a great square

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tank filled with cooling brine, holds a series of cylindrical tanks, which supply the various liquids required for the milk-mixtures used in the laboratory. The turning of a tap gives the milk. By a single connection of the hose each can is connected with a live-steam pipe which cleanses and sterilizes it perfectly. Every can, once filled, is sealed save for its single delivery tube, and the bacteria, instead of being killed, are excluded. Last of all in the series, but first in actual use, comes the huge refrigerator, where the clean milk from a model dairy farm is delivered at one side and taken into the modifier room on the other. Day after day and meal after meal pure milk-mixtures are furnished to the children, and the percentage of cases gained, and the number of children who pull through despite the handicap of the slum, is the best certificate of success. There is no institution or hospital but can profit by such experimental success as this.

One more record of modern research before we close; and this is another chapter of that great theory which shows the possibility of destroying germs of evil within the body by means of their enemies, the germs of good.

It has long been known that certain health-giving properties belong to buttermilk, but the scientific value of this fact has only recently been recognized. It was found that in certain cases this liquid was extremely successful in curing digestive difficulties. That gave a clue to start the development of the theory. If buttermilk, stripped of much of its value in the butter-making, and dirty from the process, would do this, could not clean milk be so treated as to make it of greater value? Experiment after experiment along this line has been tried. In the most successful of these a pure culture of lactic-acid bacteria is added to clean milk to acidify it. Sufficient of these bacteria are introduced to produce a maximum of seven tenths of one per cent of lactic acid, a quantity which curdles the milk but gives in the soluble part a goodly growth of bacteria. These tiny warriors are the deadly enemies of putrefaction; once within the body, they struggle with the bacteria of evil which have taken lodgment there, fighting on until they destroy them. Though a different type of action from the antitoxine in diphtheria which destroys the poisons brought by that germ-disease into the sys-

tem, it is another step toward the prevention of disease by neutralization. No slight possibility for the future is such safeguarding of food by use of good bacteria to fight the bad. Among the many attempts tending toward the stamping out of disease, this discovery may stand as a precursor of great and noble deeds.

Probably the best results obtained to-day have come from the union of private enterprise with the physicians of the city and with the lay allies of reform. The encouragement of such united action may well become a public duty. Wherever wagons upon the street bear the sign "Certified Milk," two things are likely to be true,—that the farm from which the wagon comes furnishes good milk, and that the dealer selling the milk has little difficulty in procuring customers. The sign is a valuable advertising asset. Certified milk means, first, that a certificate has been issued to a dairy farm by a committee of physicians, and implies that the farm has been inspected and is in every way what it should be. It means, second, that the milk is delivered to the customer in some thoroughly satisfactory way. It is entirely possible that some features of any system like that of certification may

not be practical for certain individual cities ; but one feature, personal investigation of the conditions of the farm, should be a part of every milk inspection. In Vancouver, B. C., for example, the city milk-seller cannot obtain a license unless the farmer from whom he obtains his milk agrees to inspection. If the result of such supervision is not satisfactory, the trouble is removed by taking away the license.

And now, to summarize : First, the modern study of milk tends to the exclusion of bacteria by cleanliness and cold, not their destruction by heat. In general it considers pasteurization a fairly satisfactory substitute in emergencies where pure milk cannot be obtained. Second, mortality statistics tend to prove that exclusion is necessary for the child and for the nation. It may be that at the present moment we are a little weary of reform. The pendulum of warning may have gone too far in some directions, but in one it has not gone far enough. The lives of the city children hang in the balance to-day. If there is any means by which we can bring back ruddy cheeks and healthy bodies to children unjustly deprived of them, if there is any way in which we can lower our

present fearful death-rate, who of the community can refuse to lend interest, or give aid? The trumpet-call that summons should rouse each deadened ear, quicken each dulled soul. It is the call to a new, all-embracing, all-powerful children's crusade.

III

THE CITY'S FOOD

Out of the gray dawn, from smoky stations where grimy engines pant and heave, by lighted subways in swift, silent trains, or through the barren shuttered streets in clanging car, pour the great hosts who do the city's work. That restless river springing from the morn bears in its flood the total of the city's wealth. From its requirements rise the varied activities of the city, whose total economic power is built by massing the single units of the moving throng. The energy of this human river gathers the resources of sea and earth, and turns the wealth it gains to the use and the service of man. On the preservation of that energy, therefore, depends the effective work of the city. Higher and better living for all would come from its general increase.

To gain energy, the individual has but one means at his command, his food. Just as surely as the red flame of any coal-fed fire dies down, left unreplenished, so man dies, once his food-

supply is stopped. That is so evident, so personal, that it is remembered. It is equally true, but less commonly remembered, that as a furnace with dead ashes about the walls yields little heat despite the fire within, so insufficient or wrong foods, poisoning or dulling the worker, give him little energy for his tasks, little strength to bear his part in the world's struggle.

Stated in its simplest form, the problem of the city's food-supply resolves itself to this: how can we provide the consumer with healthful food which shall be in a normal condition when it reaches the table? If we can solve that problem, we can furnish the army who are attacking the work of the world with a proper commissary, and so supply it with a requirement second to no other. If Napoleon's famous remark, that an army travels on its stomach, applied a century ago to the invincible legions that so long dominated Europe, it is quite as true to-day that in our desperate struggle for commercial supremacy that nation which is best fed, that city which pays the most attention to the food of the workers within its walls, stands the greatest chance of ultimate victory.

Visualizing to our entire satisfaction the vegetable garden of the farm, or the white butcher's-cart of the village, as the basis of our food-supply, we, as a nation, have long been inclined to neglect the widespread sources from which we draw our bodily energy. As in so many other civic conditions, the tradition of the immediate plenty of the American farm has overcome the actual reality. What the city-dweller should visualize are the thousands upon thousands of tons of perishable food-material which are brought yearly into the city; for these, on their way to our homes, must pass through a cordon of attacking foes. The armored trains which carried provisions from place to place in the Boer war, and the forts in which those provisions were received, have no distant parallel in the refrigerator cars and the cold-storage warehouses of the city. Like supplies hastened to beleaguered fortresses, our foods are exposed to destructive agencies from the time they leave their place of origin to the time they reach their final destination. The foes that the foods encounter are of two classes, the natural and the unnatural, the forces of nature and those of greedy or ignorant men. Both types of evil can be avoided

by the community, if it will raise against them certain well-recognized guards. To raise those guards, some definite knowledge of the dangers which surround the food-supply is imperative.

In common parlance we say that an orange which has turned soft, or a piece of meat which becomes tainted, is spoiled. The housekeeper looking over the contents of the ice-chest says, "This must be eaten to-day, for it will not keep until to-morrow." In such expressions we instinctively recognize the existence of destructive agencies. It is comparatively seldom that we fully realize that what we call the spoiling of food is one of the great movements of natural order in the world, that it is the attempt of nature to do one of two things: either to encourage new life at the expense of a substance which has lived its allotted time, or to destroy and clear away matter which has served its purpose and is ready for removal. Food-materials, left under conditions where plant-life can exist, become fertile soil. Decomposition of food-materials is produced by micro-organic life growing in that soil, life which is attempting to clear away organic wastes from the face of the earth, and return the substances which have composed those wastes into such

elemental form that they can serve once more as food for plant-life.

All round us, in library and kitchen, in office and laboratory, on hill and valley, through winter cold and summer heat, flourishes the garden of the air, a garden filled with countless myriads of tiny plants. There may be found threadlike moulds such as form on bread or cheese; wild yeasts, such as ferment fruit juices and change sweet cider to hard cider; and bacteria like the mother of vinegar, which turns hard cider into vinegar, or like those other types of the same group of tiny plants which, by decomposition, break down the organic structure of the foods in many fashions.

The moulds, the yeasts, and the bacteria, all of which may be grouped as micro-organisms, share certain general peculiarities. All three belong to the great general group of fungi, a group of plants which take their nourishment from the soil on which they rest; and, like their relatives of this group, these organisms, as they grow and take in food, break down the organic matter which affords them lodging and nourishment. All three of these plant-types thrive best under conditions

of darkness, warmth, and moisture. All three flourish in dirt, and dirt is laden heavily with these tiny bodies. Cleanliness and cold are two great guards by which we can protect food against the attack of decomposing micro-organic life. The clean, cool ice-chest preserves food in the home. The hot, moist kitchen destroys it. The first, by cleanliness and low temperature, tends to retard micro-organic growth. The second, by the increased opportunity for dirt and dust and by a higher temperature, fosters the plant-life of the air.

The normal tendency of leaf, stem, flower, and fruit is to turn at last to the cellulose and lignin of the tree-trunk. In the action of organisms which attack the fallen forest tree and, decomposing it, return its elements to the ground from which they sprang, may be seen the agencies through which old life is constantly exchanged for new. Were it not for such action, the fresh and living plants which give us food might, ere this, have become locked fast in harsh, unyielding, woody fibre, which offers nutrients to neither man nor beast. Nor does such action show the only value of micro-organic life. A modern sewage-plant will be referred to later as a pile of

rocks on which bacterial films gather. The bacteria of those films are fulfilling their action as earth's scavengers when they break down the sewage flowing over them, and turn the objectionable organic wastes to simple inorganic forms.

A few short phrases sum up conditions. The natural enemies of food-preservation are micro-organic plants, which flourish the world over, ever ready for their tasks of decomposition. With foods as a common habitat, these organisms in their process of growth break down the structure of the foods into forms unpalatable and often directly injurious to man. Yet the growth of such micro-organic life is a necessity of nature. Man can oppose it only in some part. He can, however, control it, in so far as necessity requires, by cleanliness and a cool temperature. The preservation of the city's food by dryness, a third protection against the decomposing organisms, is impracticable for many of the foods because of their normal content of water.

The incoming of the city's foods is of itself a splendid pageant. Wheat trains, rushing from the wide horizon of the West; fishing schooners, tacking up from off the Banks;

refrigerator cars, hastening across the continent, laden with the spoils of a thousand herds; high-topped wagons hauled by sturdy Percherons, looming in over the country roads in the freshness of the earliest dawn; crates filled with golden oranges, with luscious peaches, with heavy hanging grapes, hastening upon their city way; huge motor-vans, piled high with dainties, speeding through the bustling streets; all such intruding, converging evidence of natural plenty offers a wide breadth of thought, a feeling of greatness, a sense of pride in this rich and glorious country in which we live.

But there is a dark reverse to this splendid shifting curtain. Down on the East Side lives a Russian Jew, a vender of fruit, who finds a hand-barrow quite large enough for all his meagre stock in trade. A weary day has gone, whose long rounds have been profitless. Back comes the wretched stock to the home in the hot tenement, to go out again, already well on in the process of putrefaction, to be offered for sale the next morning in the sweltering streets. The fruit-peddler's action in selling his damaged goods may be deliberate or ignorant; whichever it is, matters little as regards

results. Nature makes no allowances. Her laws are inexorable. Food such as this, uninspected and uncondemned, ravages the weakened frames of the city's poor, and the exhausted doctors, those warriors of the high-walled streets, report after such a sale, "Another epidemic caused by rotten food." One great necessity for inspection is laid bare by such conditions.

While ignorance, while deep need (for the loss of one day's stock may mean starvation to the seller), while greed, can control the actions of the small provider of food to the ranks of the poor, the city must guard its children. Go into the slums of your city, and enter the small grocery and the butcher-shop. *Cleanliness* and *cool temperature* I gave as the two great guards against the decomposing action of the micro-organisms. See how the shops of the tenement streets provide those guards, and then read the general death-rate from intestinal disease in the summer. Put milk in a separate category, for that is a still greater problem, and, even with that omission, you will have much to ponder over.

The men who use adulteratives, the sellers of "embalmed beef," and the venders of other

substances which have been treated with injurious types of preservatives, can hardly plead ignorance as an excuse for the continuance of their methods. The discussion of pure foods which has gone on in recent years, the pure-food laws which have been passed by federal and state authorities, have been sufficient to enlighten any manufacturer as to the necessities of the situation. But so long as crime is committed for the sake of gain, the public must be protected against the deliberate attempt of unscrupulous manufacturers and dealers in foodstuffs, who work injury in the pursuit of their own profit.

Indeed, it may hardly be too general to say that the evil done to the city's food by its unnatural foes may be divided into three classes. These may be stated as follows: First, men may deliberately offer for sale food which has begun the process of decomposition. Second, they may treat food with preservatives which, while they destroy or prevent the action of micro-organisms, are injurious to the human frame. Third, they may adulterate, or substitute, cheaper, poorer foods for better, more nutritious foods.

"But," the reader will very possibly cry in

surprise at this point, "I thought all that had been settled. How about the pure-food laws that have been passed? How about the work of the Boards of Health? How about the crusade of the last four years, mentioned a moment ago? We may not be able to control the natural foes of food, but surely there are laws to control the unnatural ones."

It is almost a national fallacy to believe that once a law has been placed upon the statute-books safety has been secured, even though such a law has been passed without sufficient enforcing power, or sufficient money to provide for proper enforcement. Much has been done; no inconsiderable beginning has been made; but large bodies move slowly, and the impetus necessary to arouse general feeling to the point where the American people will require proper inspection and control of all food-supplies is still far from attainment. Without attempting to enumerate the merits or defects of all the statutes which have been passed for our protection, suppose we consider for a moment certain difficulties which surround the most general law of them all.

Whatever the local condition around him, the citizen who thinks of the matter puts his

trust chiefly in the Food and Drugs Act, passed by Congress on June 30, 1906. Three analogous pieces of work accomplished by the national government: the law just cited, with its regulations, alterations, and amendments; the work done on standards of purity; and the so-called "Meat-Inspection Amendment," which regulated the meat-control of the Department of Agriculture, contain much that is admirable. From the very nature of the relation between the federal and state authorities, there are many things that the nation cannot do. Two brief quotations from the Food and Drugs Act may serve to make this clear.

This is "An Act for preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes." Section 1 provides, "That it shall be unlawful for any person to manufacture within any Territory or the District of Columbia, any article of food or drug which is adulterated or misbranded, within the meaning of this Act." Section 2 provides, "That the introduction into any State or Territory or the

District of Columbia, or from any foreign country, or shipment to any foreign country, of any article of food or drug which is adulterated or misbranded within the meaning of this Act, is hereby prohibited."

These brief quotations show the limitations of federal law. The Territories and the District of Columbia are under the direction of Congress. The shipments of foods from state to state, like export and import, can be controlled by officers of the national government; but the traffic in food-supplies which goes on within the borders of any state must be regulated by the government of the individual state. Each of these bodies politic presents a different solution of the question. Certain states have met the problem bravely, have endeavored to solve it by the aid of expert opinion and without reference to the clamors of special interests. Some few (a most essential point) have endeavored to back up their laws by boards of control, with inspectors to carry out their mandates. In other cases, the cry of selfish interests still dominates the assemblies. Laws, if passed at all, are passed without sufficient reference to expert advice, and by their verbiage are practically nullified. The thou-

sand demands for money which the long-established departments of our commonwealths bring forward, leave little to spare for the newer sanitary inspection, necessary as such a department is for the health of the citizen.

Multiply the difficulties of the nation by fifty, more or less, and you have the difficulties which confront proper food-regulations in the states. Multiply the fifty of the states by hundreds reaching into thousands, and you have the difficulties which are before the municipalities when they desire properly to control the food of the individual citizen. Yet, as we get down to the intra-mural conditions of the municipality, some balancing conditions appear. These we shall consider in a moment.

That crowded concourse, the modern city, which has left behind the possibilities of individualistic control, has been forced, step by step, to a collective control of its prime necessities. The paving of the streets, the protection of the houses from fire and theft, the education of the children, have long been wisely placed under the municipal government. Defective administration of these departments calls for swift correction. Is the insurance of the healthfulness of food, that vital question

which so intimately touches the welfare of each individual, of less importance than these? The body in which the control of food is vested is commonly the Board of Health. Have you seen headlines in your morning paper within the last year or two, referring to the holding up of an appointment to that body, or to the rejection of a candidate because of political beliefs? How many cities have reached the point of making a man trained in scientific methods, especially a sanitarian, a member of such a board? The medical men of such bodies are doing an invaluable service. How many of the problems which confront them could be solved by men with the training of the engineer? The state can do little in regulating the affairs of all the municipalities within its lines. The adjustment of home conditions must depend upon the men whom you elect in your cities. Once more, bring the matter to the *argumentum ad hominem*: what do you personally know about the health-control of your own city?

Fortunately, our instinctive training of centuries past does much for us in the way of protection. The table of our earliest forbears was limited in the extreme, and its variety could

be enlarged only by experiment. A tempting cluster of berries on some shrub in the neolithic forest might be a delicious dessert, or it might be a violent poison. Brave experiment alone could determine which. It was a hard predicament. If the early-research man guessed right, he had a valuable addition to his diet. If he guessed wrong, he died. Blunted as our senses are by centuries of civilization, the instinctive training which primeval man received in the choice of good and bad food has persisted to this very day. The evidence of the senses is no mean aid to assist the buyer of the household's food-supplies to ward off evil. But the senses are an insufficient guard at best. Two factors in the city are constantly arrayed against them. First, the resources of the man who deliberately doctors his damaged goods in such a way as to disguise their real condition, — the seller who renders impure goods savory to the taste and pleasant to the eye; and second, the desperate need of the poor. And after all, defective conditions in the city always bear most heavily on that class, on the ones who can endure them least easily. The poor suffer most from bad air, bad water, and wretched food. In few respects are they

more heavily handicapped than in their choice of food. The lesser cost of damaged goods is a fearful temptation to the slender purse of the ignorant woman of the tenements; the stores where she buys her food-supplies offer but little choice for well or ill. Few more immediate duties confront the municipality to-day than the guardianship of the food of its poor.

We cannot better conditions by not recognizing them. While money rules the world, men will sell impure or damaged food-supplies ignorantly or wickedly; and since the national law cannot affect the sale of goods of this sort within the boundaries of the state, we must pass state and municipal laws for our own protection. To make them effective, they must be intrusted for enforcement to competent men, backed by ample supplies of money. Obtaining a maximum of control with a minimum of money is a theme inseparably connected with the centres of sale of food-supplies, the markets, abattoirs, and bakeries. That brings us directly to those important considerations.

The Old World shows the market in its first stage and in its last. The New World, save here and there in scattered foreign quarters or in the great marts of trade, shows stages in

between. Rise early any morning in the little German town, and stroll along the cobbled streets to the square where the church so often forms the background of the market-place. There you will find the direct successor of the *ἀγορά* of the Greek, the *forum* of the Roman. The market-woman under her broad umbrella ; the picturesque peasant with his rude country-cart filled with fresh produce ; the frocked butcher weighing a piece of meat in his niche in the wall : each is selling his wares under practically the same conditions that prevailed two thousand years or more ago. Such markets offer an example of the most primitive type of trade, direct barter between the producer and the consumer ; a barter carried on, in some German towns at least, under strict surveillance of the health authorities. In more than one market of that type I have seen a cleanliness and an order foreign to far better theoretical conditions in American cities.

Paris offered to the world the first great example of the modern market, built and controlled by the government. Napoleon the First, warrior, statesman, jurist, and sanitary engineer, found time among his many labors to accomplish many salient municipal and gov-

ernmental reforms. The great "Halles Centrales" of Paris, those iron-pillared, zinc-roofed pavilions through which run covered streets, were planned under his direction, and begun in 1811, in his reign. These markets are said to cover not far from twenty acres, and their pavilions are subdivided into numerous tiny stalls. The early example of the Halles Centrales has been carried on since by similar markets built in other parts of Paris, and the profits which the municipality has realized from these sources have been large.

London, Berlin, Vienna, and other European cities soon followed Paris in the work of regulating the food-supply, and have raised markets on an almost monumental scale during the last half-century. The American markets cannot be compared with those found abroad, in size, completeness of equipment, and ease of control. To particularize, such markets as the Fulton or Washington in New York, or the Faneuil Hall Market in Boston, are not in the same class with the great modern markets of the European capitals.

While the single market in the town square sufficed temporarily for the small segregated town, the gradual spread of population soon

carried with it separation of the centres of food-supply, so that grocery and butcher-shops sprang up in every little sub-centre of population. The opening of such scattered shops has greatly increased the difficulty of bringing food in its best condition to the consumer. Berlin, with its fifteen great markets, can control each one by an individual corps of attached inspectors, and do this at a minimum of expense. To secure thorough inspection of the widely scattered food-shops of New York and Chicago is vastly more expensive and trying.

If we assume two premises, that a proper control and inspection of food-supplies makes for the good of the city, and that such control and inspection should be carried out at a minimum of expense, four questions confront the interested citizen with regard to the markets of the community. What are the advantages of centralized markets as opposed to our present separated ones? What should be the general location of such markets? What should be the general internal construction of the buildings? Should the ownership of the markets be vested in the public, or should they be under private control?

City reservoirs have long taken the place of the garden well; and city water, because of its distribution from a main source of supply, can be readily inspected for its purity. The furnishing of food-supplies must always remain a problem strongly distinct from the furnishing of the first-named great necessity; yet city water, entering at a single point and radiating out through different streets to individual houses, may furnish us with a valuable analogy. By a system of centralization comparable to that already employed with water, the establishment of centralized markets will do away with a large part of the difficulty of control. Such movements have proved direct magnets to trade. Such markets have become the centre of the food-movement of the city. Centralization has shown other merits besides the primary one of control. In the smaller city a single market may be used for wholesale trade in the early morning hours, and for retail trade during the day. In the greater city a division into parts, with a great wholesale market as a main source of supply, and a radial series of retail markets placed at subcentres of population and fed by the central market, would seem to be the ideal arrange-

ment. Such a hub-and-spokes arrangement should prove particularly effective when we consider its possibilities with regard to building markets for the poor, a matter to be considered in some detail a moment later.

The general location of the markets should be determined chiefly by the conditions of transportation. With vegetables and fruits, as with milk, it is essential to their purity to transmit them to the consumer in the shortest possible space after their preparation. Those markets accomplish the swiftest transfer of goods to the receiver where cold-storage cars can deliver directly to the doors, where the laden wagons from the adjacent country-side can most readily bring their fresh-gathered goods, or where inland waterways or ocean docks are close at hand. Every such central market should have its cold-storage warehouse, and its devices for supplying cold storage to the tenants who rent the stalls. Convergence of transportation to a single point is one of the best safeguards of food. Swiftness of delivery and continuance of low temperature oppose the decomposing action of the plants of the garden of the air. The location of the sub-markets in a radial system must, of course,

be controlled by the position of the centres of population. In these days of motor-wagons and tube-systems of delivery, the problem of transportation from a central point to the minor marts becomes a by no means difficult matter.

Not the least argument in favor of centralization may be found in the increased facilities afforded as regards garbage removal. The need for a satisfactory service of this kind may be readily recognized when two statements are placed side by side. The natural enemies of pure food flourish almost beyond belief in the organic wastes cleared from the food-shop. Some of our better ordered municipalities think it sufficient, even in midsummer, to collect garbage but once a day. Other less progressive cities believe their duty done when the accumulated wastes are removed twice a week.

The construction of markets is, in its detail, a matter for architect and engineer; but since laymen must use the finished work, the simple details laid down by William Paul Gerhard, in his excellent work on the "Sanitation of Markets and Abattoirs," may be quoted:—

"The chief constructional requirements [of markets] are the following:—

"1. The halls must have ample light.

"2. They must not be draughty, yet be well ventilated.

"3. They must afford plenty of floor space and storage room.

"4. They must have plenty of exits and passageways, also driveways for the unloading and loading of wagons.

"5. They must be well and substantially constructed."

Those five sentences sum up the requirements well.

Now for the answer to the last of the four questions, public versus private control. If the modern theory is correct, which assumes that it is a part of the duty of the municipality to care for the health of its citizens, it is surely a legitimate function of the municipal government to undertake the building and ownership of public markets. The tradesman who rents the stall from the municipality comes, by that act, directly under the rules which may be laid down for the control of the market. The inspector who condemns goods in accordance with such rules has no mean

moral support behind him. In consequence, the customer who buys his household supplies from the centralized municipal market has a better chance of protection than in buildings where private companies, seeking the largest dividends possible, may be in conflict with the officers of health. Nor need such a venture be an altruistic one. The ownership of public markets has proved no losing venture for many cities. Yet the municipality, if the movement is to prove of its utmost value, should not look toward making dividends, for the ultimate purpose of such ownership is not the immediate pecuniary gain, but rather that more general gain that results from the better health and greater energy of a well-nourished people. Beyond all else, markets so built and so controlled should result in advantage to the class which needs them most, the city's poor.

Few luxuries are more expensive than the five cents' worth of the poor. The cost of lodging and food, two of the absolute necessities of community life, is a tremendous problem to the great majority of the city-dwellers. To the poor the margin by which these are secured at all is scant indeed. It is the more pitiful, therefore, that only in the luxurious

shops of the rich do foods cost as much as among the tenements. The small quantities consumed, the meagre variety, the hand-to-mouth method of buying, all combine to make the nourishment obtained far less than it should be for the money expended.

Municipal markets placed less to accommodate the rich or well-to-do than to reach the buyers of the tenement district, markets whose stalls offer the variety desired by the many races who make up our cosmopolitan whole, are a most immediate necessity. The Italian emigrant woman, bewildered for years by a new land and by strange customs, will seek the dirty Italian shop in the back street, if there are no stalls in the public building where she can chaffer in her own tongue. The extortion of the small shop cannot continue where the entering buyer passes a hundred stalls offering the same quality of goods. Once more let us reiterate a salient point. The cost of stalls in such markets, the necessary running expenses for keeping up the business, should be distinctively lower than those charged by the tenement landlord outside. The municipality cannot afford to have its markets too profitable an investment. Sick-

ness from poor food, lack of energy from insufficient nourishment, are fearful drains on a city's total resources. The proper control of markets is a step along the lines of preventive medicine.

The meat-stall of the market must buy its goods from the slaughter-house or abattoir. No other part of the providing of the city's food has come to the attention of the public as has this single trade. Mr. Upton Sinclair's novel "The Jungle"; the report of the commission named by President Roosevelt to consider conditions in the abattoirs; the work of the illustrated weeklies and the daily newspapers, — all have combined to stir the public deeply. The past is a matter of history, and the former conditions of many of the slaughter-houses have proved to be wretched beyond belief. The reforms accomplished have already been considerable, a result due largely to the fact that most of the abattoirs are engaged in interstate commerce, which fact places them under the control of the national government. Numerous smaller abattoirs catering to local trade still exist, however, and the same general statements that apply to the public ownership and control of markets may well apply to these.

Certain characteristics of the work of the abattoirs differentiate their problems from those of the markets. The very nature of their business is of a more filthy and disagreeable sort, and demands especial precautions with regard to cleanliness and the preservation of the products. The wholesale nature of the trade allows the abattoir and the stockyards, which normally are adjacent to it, to stand in a location outside the centres of population. Not only the unpleasant features of the slaughtering business, but also the odors due to utilization of the by-products, such as the making of soap and the handling of hides, horns, and hoofs, make it extremely inadvisable to locate abattoirs in residential sections of any class.

One model abattoir erected recently in New York has commonly been referred to of late as presenting an excellent example of what a plant of this type should be. Abattoirs may be divided into two general classes: those but a single story high and extending over a considerable ground area, and those which are several stories high and extend over a comparatively limited area. The abattoir of the New York Butchers' Dressed Meat Company is of the second type.

In this slaughter-house the cattle coming from the cars at the gates follow two white bell-wethers up long graded inclines, rising story after story, till the roof is reached, where the pens for the steers are located. Below the beef-pens are pens for calves, sheep, and lambs. All of these are open to the air. From the roof the operations of the abattoir go on in regular order downward from floor to floor. The floor below the roof holds the slaughtering-room, where all slaughtering is done in "kosher" fashion. Below are the refrigerating rooms, which are kept at a constant temperature of two degrees above freezing. Below these are rooms for the utilization of the various by-products of the slaughtering. Every part of the animal is used for one purpose or another, and cleanliness is the law of the establishment from start to finish.

The market stands before our eyes: the abattoir carries on its work beyond our vision. Yet the same need exists for both, — control brought into being and sustained by a firm public spirit, a reliant public opinion.

The bakery, a third general distributor of food-supplies, needs the same protection against the enemies of food as that claimed by

the market and the abattoir ; centralized municipal ownership is hardly practical in this case, but the need of civic regulation is a vital one, which presses more urgently year by year.

The disappearance of the art and practice of cooking in the homes of the city is one of the noteworthy signs of the age. The girl in employment, whether she gains her wage by labor in the mill, the department-store, or the office, has had little chance or inclination to take up the household sciences before marriage. Her mother, though of the generation before, is likely to have had much the same experience as the daughter, can offer but slight knowledge, and has little skill as a teacher. As an inevitable result, thousands of families fall back on the baker to make up in some part the deficiency in home training. City after city uses baker's loaves to the number of tens and hundreds of thousands. The enormous increase in the production of cooked food in the city is pregnant with matter for careful consideration.

Stand waiting for your car beside a corner bake-shop, when the mills are pouring out their living stream at night. Watch the long line entering the bakery, standing at the corner,

receiving the evening loaf or leaving the doors laden with pastry and cake. Much of the bake-shop's wares offer a soil as fertile for bacterial hosts as the goods of the market can afford. The market's goods are commonly uncooked. They must pass through the antiseptic processes of cooking. The bake-shop's viands are cooked and ready to be eaten. Note the cloying, sickish smell about the ordinary bake-shop on a summer's day, and observe the swarms of flies striving for entrance. Flies are notorious carriers of disease. The bake-shop, the source of most of the cooked food of the community, offers a problem distinct from, but no less important than, that of the market or the abattoir.

The salesroom of the bakery may or may not be attractive, but the real crux of the problem does not lie there. You will find that in the bake-room, commonly a close room situated behind the shop, or perhaps below it, in a dim cellar. Strange to say, the condition of the bakeries, with their possibilities of the direct transmission of disease, has been largely overlooked in the crusade that has gone on during the last few years. Grave possibilities of danger inhere in unclean bake-houses, heavy

with fetid air, hot with the constant radiation of the ovens, and fouled by the burning of gas-jets that strive against the dusk at mid-day. Massachusetts has done good work in clearing up the wretched bakeries of the slums, and for this the Commonwealth should be given credit. Here are two quotations from the state law on the subject which are aimed directly against certain of the chief evils which exist in this trade.

Chapter 75 of the Revised Laws of Massachusetts provides in Section 20: "All buildings which are occupied as biscuit, bread or cake-bakeries shall be provided with a proper wash-room and water-closets, having ventilation apart from the bake-room or rooms; and no water-closet, earth-closet, privy, or ash-pit shall be in, or communicate directly with, the bake-room of any bakery." Section 29 says: "Furniture and utensils in bake-rooms shall be so arranged that they and the floor may at all times be kept clean and in good sanitary condition."

Space is precious in the tenements. Air and light are costly. The salesroom shows. The bake-room is hidden. Only through municipal or state control and proper inspection can we

be sure that the evils of the bake-shops are avoided. Nor should this subject be closed without reference to the individual public spirit of some of the men engaged in the bakery business on a large scale. Some of them have done excellent work in this regard, and their efforts should receive a greater support from the community. With the exception of the large biscuit or cracker bakeries, the national laws in general have nothing to do with these food-producers. Their trade is commonly carried on within the confines of the city which they serve.

The sinister threads which mark the pathway of the pathogenic organisms, of the germs of disease, run blackly through all the discussions of those common necessities of mankind, — air, water, and food. Ever at the gates, they watch for the chance opening which shall give them entrance. Control of the diseased employee, the tuberculous patient, should not be confined to his relation to air, water, and milk : every man who handles food-supplies in market or abattoir, every worker in the bake-shops, should undergo constant and vigilant inspection. The danger of food injured by decomposition may be somewhat less in the

bakery than in the market or abattoir, but the danger to the public from adulteration, substitution, or the transmission of disease is quite as great.

Back through the hurrying, home-bound crowds, into the dusk where the lamps are gleaming, returns the city worker at the close of day. Whether the weariness of the night gives place to rest and power in the morning depends largely upon the food that the home table provides ; and the healthfulness of that food, gathered as it is from many different sources, must be controlled by the individual citizen, in the end. Only by the deterrence of the knowing criminal who furnishes impure food, and by the teaching of the ignorant, can general safety be secured. Nor is it enough to insure our own safety only. This complex latter-day organism, the city, when injured in one fibre, transmits the hurt throughout its frame. Whether we wish it or no, to keep ourselves, we must be our brother's keeper. Only when we strive to guard our neighbors as ourselves are our own walls secure.

IV

THE FOOD OF THE INDIVIDUAL

POWER is the text of half the industrial sermons preached to-day. It is the factor which demands the conservation of our forests, our rivers, and our other national resources. It is the strenuously sought goal of mechanical engineer and of electrical engineer, of student of hydraulics and of aeronautics. Scarcely a month goes by without scientific journals placing upon record the development of new water powers, — and all this change of potential energy into kinetic energy has to do with the inanimate matter of nature; with coal burned to generate steam; with water turning busy mill-wheels; or with gases exploding in cylinders and driving forward pistons. How many manufacturers, watching the long stream of operatives pouring from the mills at night, have ever considered that the problem of increasing the total efficiency of that hurrying crowd by the increase of the efficiency of each individual might have a personal application?

Many an employer thinks thousands a year well spent in buying good fuel instead of bad, in keeping his machines at the maximum degree of efficiency by repair and replacement. Many such a man has never realized that like care, as regards the substance that furnishes both fuel and repair to his workman, might bring an efficiency to his factory, an increase of power to his force, which would make his other saving seem trifling by comparison.

The study of food in its relation to the efficiency of man as an individual has long been recognized by the occasional student. With one remarkable exception, the consideration of food in its relation to masses of people, to the general upbuilding of the state, is of comparatively recent growth. And to-day, much of the discussion along this line is based on results rather than upon causes. The body is an organization of many chemical compounds subject to nature's immutable laws. The foods which repair lost tissue or provide heat and power are chemical compounds as well. Since all food problems concern both body and foods, some mention of the composition of the foods and some review of what has been happily

termed "the human mechanism" may not be amiss. We shall turn from that review to consider certain problems of food which closely affect the city-dweller.

The wide discussion of diet which has sprung up in recent years is by no means settled. Specialized régimes, guaranteed to procure immediate efficiency, have been brought forth by the score. Some have persisted. Many have died. It is well to pause a little and consider some of the results already obtained, to see if investigation has given us any clue as to the kind of diet which will do most for man.

We may state our first problem thus: Can science propose any diet which will offer greater efficiency than a varied three meals a day? There can be little doubt in the mind of one who knows anything of the kitchens of the tenement houses, that it is hard indeed to insure proper home food for the workman, his wife, and his child. The second problem before us, therefore, is: What can be done to stop the tremendous waste of personal efficiency caused by the poor food provided in the home? The third problem must deal with the possibility of collective instead of indi-

vidual effort. It may be stated thus : Can corporations or associations, dealing with masses instead of individuals, give impetus to the movement for proper food ?

On the shelves of one of our museums reposed for years a series of cubes and cylinders supposed to represent the proportions in which the various elements occur in the body of a human being of average size. I can feel to-day the strange and somewhat awful fascination by which those longer cubes, marked nitrogen, oxygen, carbon, and hydrogen, those shorter cubes, marked phosphorus, sulphur, chlorine, iodine, sodium, potassium, calcium, magnesium, and iron, dragged one small boy's footsteps to their solemn shelf despite the attractions of full-rigged models of Chinese junks and armored Indian warriors. Those cubes showed the essential parts of the body's frame, the lifeless elements which, by the magic of living processes, build up the sentient organism, man. Since man is compounded of these elements, his food, from which alone can come the structure of the body, must be made up of these same substances.

The meal which provided power for your morning labor or evening pleasure, however

apparently diversified it may have seemed, was wholly composed of five simple classes of nutrients, or substances which nourish the body. These nutrients are built up from the elements just given. Though some students divide the foods into more divisions, the five classes of nutrients which we shall consider are proteids, carbohydrates, fats, inorganic salts, and water. Each does its special part, some by producing tissue or a form of energy, some by aiding the processes by which other members of the nutrients are made available. Stating a few of the common foods in rough percentages of these nutrients, we find that bread has 37% of water, 8% of proteid, 50% of carbohydrates, 1% of fats, and 2% of salts ; milk has 86% of water, 4% of proteid, 5% of carbohydrates, 4% of fat, and 0.8% of salts ; lean beef contains 72% of water, 19% of proteid, 3% of fats, and 1% of salts ; while peas contain 15% of water, 23% of proteid, 57% of carbohydrates, 2% of fats, and 2% of salts. Whether found in bread or cheese, meat or lettuce, each individual of these classes acts on the body in very much the same way, and the relation of food to the efficiency of the individual must be considered in terms of

these basic groups rather than in terms of the foods made up by them. If we eat meat, fish, or eggs, we are increasing our proteid ration. If we eat bread, cereals, vegetables, or fruit, we are increasing our carbohydrates. If we increase our amounts of butter or olive-oil, we are adding fats.

Like most important modern businesses, the body is a well-equipped manufacturing plant, and many factors enter into its life. Every productive factory must be kept in efficient condition by repair. Proteids supply repair-stuff to the body. In the factory a power-plant must supply the energy which runs the machines, and a heating-plant is needed to warm the rooms and give heat for various processes. Carbohydrates and fats, burning in the oxygen drawn in through the lungs, supply the body with such energy and heat, while a part of the proteids, not used for repair, does some share of this work. A thorough supply of water for washing, cleansing, and preparing the materials used is commonly required in both businesses. A large up-to-date establishment would certainly have an interior railway to carry fuel, raw materials, and completed products from one point to another. The circulating

blood serves as an interior railroad, which carries fuel, waste-supplies, and finished goods through the whole human plant. In our study of the nutrients, water and mineral salts, essential as they are, need but little consideration. It is the three other classes that demand our attention.

The carbohydrates and the fats have a mission besides their chief one of the provision of energy. They are the storehouse employees. It is a part of their duty to see that reserve supplies of food are put away in the body-storehouses, in sufficient quantity to carry the body along when food is scarce or when the machinery is temporarily out of order and incapable of use. The exhaustion of those supplies during illness, as exhibited in the shrunken frame of the convalescent, is a common testimony to this employment. When more of the combustible compounds of this class are taken than are needed for immediate use, a part of the surplus is turned into fat and stored away in the body against time of need. Essential as such storage was when prehistoric man, having breakfasted, knew not where his dinner roamed the forest, to-day that overworked machinery of supply too often produces the

disease of the well-filled table and the sedentary life, obesity.

The proteids belong to the repair staff. They are those nutrients which serve to repair the living moving portions of our body ; like muscles and glands. It is this repairing power which differentiates them from the more strictly fuel-foods. Every part of the living tissue which composes our mechanisms is made up of cells, living masses of various size, each of which is complete in itself. These cells are themselves of proteid structure, and the nutrient proteids are the chosen foods to which are intrusted the important task of caring for the cells, of building them up and keeping them in condition. Two elements found in the cell, nitrogen and sulphur, are found only in, and can be supplied only by, proteid. No part of the problem is more important to us than a knowledge of proteid demands. Life is a constant change of form, an incessant building up and breaking down, and the disintegration of the cell, the loss of proteid in the human body, never ceases. In sickness and in health, sleeping or waking, working or resting, the nitrogen and sulphur of the cells is breaking down and changing from living active sub-

stances to dead wastes ready for removal. A constant supply of proteid in one form or another must be received, or life stops as surely as the mill shuts down when its worn-out wheels and pulleys, left unrepaired, slow down for the last time and stop, incapable of longer transmitting power.

From the facts already stated we must believe that some proteid is necessary to life. We have by no means settled how much proteid is required for man's greatest efficiency. That problem has long been a vexing one. The whole question of how often meat and fish shall appear in the diet is involved in its answer. It divides into the perils of too much and too little, and the man who wishes to learn what to eat himself, or what to advise for others, is bound to be perplexed. Carl Voit and his followers form the school which believes in a comparatively large proportion of proteid or nitrogenous food. This is the diet which most nearly corresponds to that of the average person. These students believe in general that a man should take from 110 to 130 grammes of proteid a day, — a fairly generous meat diet. Remembering that all such figures are merely approximations, and that physical condition, age,

occupation, and sex are all factors which affect quantity in diet, we may try to translate that requirement into terms of two or three foods. If a man bought about a pound and a half of lamb, of sirloin steak, or of halibut, ate the edible portions, and took nothing else containing proteid all day, he would approach Voit's ratio. Sirloin steak contains 16.5% of proteid. Leg of lamb contains 15.9%. Halibut contains 15.3%. Of course, in practice much of the proteid taken in by any individual comes from the bread, milk, vegetables, etc., of the diet. It is almost never provided wholly by the meat. A middle course as regards proteid is held by Armand Gautier and others, who would cut our meat diet by perhaps a third, and limit us to 80 grammes. Probably the lowest diet in point of nitrogen of those not strictly vegetarian is that proposed by Professor Chittenden of Yale in the historic experiments published in his book on the "Physiological Economy of Nutrition." A brief résumé of that research follows.

Professor Chittenden divided the subjects of his experiments into three general divisions. The first was made up of five men of varying ages connected with Yale University as pro-

fessors and instructors. These teachers represented the man of somewhat sedentary life, the brain-worker rather than the physical worker. The second group was a squad of thirteen men from the Hospital Corps of the army, who took moderate daily exercise in the gymnasium and represented the man who combines both physical and mental labor,—the skilled worker, for example. The third division was composed of students, all Yale athletes, who represented the man taking severe and prolonged physical labor.

Each of the groups lived for some months under constant observation. Each passed from the common meat diet of an ordinary man, 110 to 130 grammes of proteid per day, to an extremely low meat diet, generally less than half the usual amount; and each was not only able to do a full quota of labor on the limited amount of proteid which he consumed, but was even able to accomplish more work and keep in better health than had formerly been the case. The long research ended with a firm conviction in the mind of the experimenter that the subjects of the experiment came into "nitrogenous equilibrium" (we shall consider that phrase later), and maintained a thor-

oughly healthy condition of body and mind, with about one half the proteid that the ordinary individual uses in his diet. Professor Chittenden believes that on this lower diet the body increases in efficiency and undergoes less strain, while a very large saving in the amount of money spent for food is possible.

Remarkable as were the results of that distinguished believer in a greatly reduced intake of proteid, with its greatly lessened diet of meat, the great hosts of individuals who form the race have, through centuries of experimental evidence, gained an experience and formed a research on a vastly greater scale, where the inaccuracies of observation seem more than counterbalanced by the millions who have performed the experiment. Occidental man has always taken a moderate meat diet when he could get it; and the change from a narrower vegetarian to a broader meat diet has always been a change accompanying a higher standard of living. The limited proteid of the peasant has never seemed to give greater mental or physical vigor than the larger proteid diet of his lord. One point stands saliently forth throughout every experiment along this line. Whatever

may be our judgment of the advisability of high or low proteid, some proteid is necessary. In the balanced ration lies safety, in the proper mixing of meat and bread and vegetables, in the acquiring of sufficient proteid to support "nitrogenous equilibrium." The nitrogen balance is one of the keynotes of modern scientific feeding. Generally speaking, this nitrogen balance means that the amount of nitrogen taken in as proteid in food equals the amount of nitrogen given off as waste. According to this theory, a man at full labor and in good health, neither gaining nor losing in weight, breaks down on an average as much of the nitrogen-bearing proteid of his cells, in doing his work, as he puts in in the form of the proteid of his food. A man must take a sufficient amount of proteid to take care of his repair-work, or he will be infringing on his body-capital. The fats and carbohydrates consumed do not balance as does the proteid, since, as we have seen, that part of these nutrients which is not used immediately for heat and power is largely stored in the shape of fat.

In the necessity for a nitrogen balance we find man once more coming under the con-

trol of one of those mighty laws that underlie the universe and all its manifestations, the law of the conservation of energy. When man absorbs sufficient nitrogen for the nitrogen balance, when he preserves the ratio of other foods which will support that nitrogen and keep the body organs in action, he possesses the necessary energy for his labors. If he takes too little proteid, he uses the very substance of his body in carrying out his daily tasks. If he takes too much, the elimination of the wastes, which increase as his proteid increases, becomes more than his body can handle, and he overloads his machine, breaking down the organs.

The relation of this last statement to our modern city life is close. As the individualistic city home fades further and further from our ken, the tribe of hotel-dwellers develops more and more digestive difficulties due to overloaded organs. The American who eats eggs or chops for breakfast, steak at noon, and fish, meat, or game at night often stores up trouble for himself. Carbohydrates, whose removal from the body is comparatively simple, contain carbon and hydrogen, which burn to the gases, carbon dioxide, and water. The

body mechanism can safely carry no great excess of these; but the proteids are worse, for they break down into probably deleterious compounds, whose elimination is much more difficult. The average business man and his wife are over-fond of proteid foods, from whose elimination may come serious digestive difficulties. The school which follows Mr. Fletcher in his belief that extremely complete and thorough mastication is one way out of the difficulty, may owe no small portion of the success they have attained to the fact that, owing to the limitations of time, its members are unable to consume an excessive amount of proteid in a given period. In a balanced ration, which provides sufficient fat and carbohydrate for heat and power and sufficient proteid for repair, lies the only safety.

Excepting among the poor, the average man is more in danger of over-feeding proteids than carbohydrates, but there is one instance of the latter condition which should not be overlooked. This danger comes from the persistent crusade in favor of cereal products. It illustrates the harm which may come from a one-sided food wrongly advertised. If you turn over the pages of the first advertising

section which reaches your hand, you will see that a large percentage of the foods advertised there are cereals. Cereals are excellent and valuable foods. It is entirely right and proper to advertise them. Their advertisement becomes questionable only when the greater part of the effort made is to impress on the buying public the idea that these foods, and these foods only, provide the ideal diet. A breakfast from some of them is claimed to contain exactly the ingredients needed for strength and energy, while a saucer or two at luncheon and a pudding made of the same substance for dinner will, they consider, produce a harmony of effort of body and brain unattainable in any other way.

The follower of those glowing statements takes for his medical counselor and guide the press-agent of the advertised food, the man who is employed to sell as much as possible of the product he is pushing. The man who blindly follows the press agent's directions is taking a grave chance. If our present beliefs in dietetics point to one thing more than to another, it is to the necessity of keeping up nitrogenous equilibrium. If that is not kept at a level by the feeding of proteids, the body must

draw upon its own structure to do its daily tasks, — an action which weakens its frame. The cereals are chiefly carbohydrates. Their proportion of proteid is practically never sufficiently high to give a balanced ration. All of them contain some proteid; but in order to obtain this in sufficient amount for daily use, the eater of cereals is obliged to overload his digestive organs with so great a percentage of other nutrients that he passes beyond the safety-point and fills himself to repletion. The steel bridge which bears a load beyond its power will no more surely break than will the delicate organs of the human mechanism when overloads of any single type of food are constantly inflicted upon them.

In the preceding discussion may be found some explanation of the thousand questions of diet raised in the present day. It is worse than the "Battle of the Books." On the one hand vegetarianism, on the other meat diet. The sides of the electric car beseech us to buy food to nourish brain, to produce greater powers of memory, of concentration, of initiative, or of thought. The magazines are filled with pictures of magnificently formed athletes accomplishing marvelous results by their in-

dulgence in certain picked foods. It is no wonder that the weary brain-worker of the city, hoping for greater force, turns to foods which promise immediate and special results, — that he tries “brain foods” or “muscle nutrients.”

Such search is vain. Thorough as has been the study of foods in the last few years, and carefully as the question has been considered, there is no established ground for belief that any particular food can be found which will have any special effect on any part of the body. So far as we can tell, the interior railway of the human factory, the blood, takes the same raw materials to the cells of the brain and the cells of the hand. This statement must not be taken to mean, however, that a diet limited to but a few types of nutrients is as good a body-builder as one which gives a wider choice. The comparatively recent work of Osborne and Abderhalden has shown what wide differences can exist with regard to the different forms of proteid found in various nitrogenous foods.

Reviewing the whole body of evidence, the present writer is forced to the conclusion that there is no convincing proof that the average

diet of centuries past should be radically changed. Most of the topics treated in this book are the results of unnatural conditions. Overcrowding, bad air and food are the products of the congestive rush to the cities. Many, perhaps most, of the city's problems are products of recent date. The period of experimentation with these problems has been comparatively short. The period of man's experimentation with food reaches back to the cloudiest vistas of time. In most of the evil conditions of the city we can see the evil forces actively at work. Here we are forced to turn somewhat to speculative philosophy. Some things have been established. It has been reasonably established that efficiency cannot be obtained by any royal road of overloading or of underfeeding. The rich, or those in more moderate circumstances, may overload. The poor, with the present prohibitive prices, are but too likely to underfeed. No accepted evidence exists that any specialized diet can give any more power to muscle than to brain, or to brain than to muscle. After a violent agitation of the pendulum in different directions, we are coming back to a greater belief in unspoiled appetite than ever before. We are coming to

recognize that the reasonable variation of the ordinary table, which provides its due amount of proteid, carbohydrate, and fat, is not far from right. There is good experimental evidence to show that a diet which gains its necessary nitrogen from fish, flesh, and fowl, is wise.

Starting our next division of the subject with the hypothesis that a varied, reasonably plentiful diet is the one which will produce the greatest efficiency, the hardest question is before us. How can we supply the great mass of the city-dwellers with such a diet, especially with such a diet properly cooked? Is there anything which can be done to provide, not only the food itself, but also the training which shall make the provision of such food a constantly increasing factor in the total increase of efficiency of the city? There is no small amount of sociology involved in the answer.

The working-man's choice of food in these days when prices climb skyward is difficult in the extreme. It is made much worse by the tradition of the American table. The workman of a hundred years ago generally had his isolated house and garden. His primary occupation was likely to be husbandry, his secondary, manufacturing. As Whittier's father, in

the long winter evenings, is said to have sat making shoes in his own house, surrounded and assisted by his family, so the average workman of that time preserved, like him, individualism and self-respecting freedom in his industry. The small garden of the worker supplied vegetables to the family from soil tilled by the owner's hands; and even yet such a mixture of farmer and artisan exists in many a country manufacturing town. To these people the wealth given back by the soil and the comparatively low cost of the meats that were brought by the butcher's white cart to the door, resulted in a lavish table. When walls of brick prisoned the worker and laid waste his garden, the tradition of the earlier table persisted. In whatever way the family stinted themselves, the table was the last thing to be affected. If the keeping up of an expensive table was the only way for a family to obtain sufficient nutrition, no question could be raised. But it is not. Knowledge of food-values and proper methods of cooking could provide quite as great nutrition at far less cost. To many a worker's wife a proper table long meant, and in far too many cases means to-day, expensive meats, prepared cereals, and even out-of-season

delicacies. Sometimes the money for the meal is almost wholly spent on meat, with all the accompanying ills of an unbalanced diet. To correct that especial evil there is one remedy, —training in marketing.

Even where the raw food is clean and nourishing, cooking can ruin its potentialities of good. The wife of the mill-worker is extremely likely to have been a mill-worker herself. The brief schooling of her youth ended when she reached the minimum age of exemption from school. Sometimes it scarcely began, for child-labor still eats the strength and sinew from the republic. Too often the mill-girl leaves the mill to be married, returns there till her child is born, and then, despite the best intentions in the world, becomes a mockery to the name of home-keeper. As she is utterly untrained in the science of buying food, the household supplies are poorly chosen, and cost far more than her husband's scanty purse can afford. As she is wholly unacquainted with cooking, the food which she provides too often swims in grease, or is left half-raw. Cooking is one of the essential steps in the provision and utilization of the body-fuel. The organs of digestion will not act upon many of the

foods except when they are cooked. Many a man starts to work in the morning in a state of actual starvation, because he has been unable to assimilate the food which his untrained wife has prepared for him.

The worker in such a condition may readily prove more of a loss to his employer than would be occasioned by his mere personal loss of efficiency. The average workman to-day is employed in doing a minor detail of some expensive operation. He cares for one single action of a complicated machine. He lays the single rail that bears the train. There is a grave possibility that the bodily ills, which follow insufficient nutriment, may cost money and lives. The tendency to drunkenness among the proletariat comes in many a case from a desire to obtain quick energy not supplied by proper food, or from a wish to deaden the pangs of that frightful disease, the indigestion of the poor.

More than one factor determines the efficiency of the workman, the living mint of the city. Some of these have been stated elsewhere. One we may state here. Back of campaigns of education or socialistic propaganda stands the necessity of training the wife of the worker

in choice of foods and in cooking. The training of schoolgirl or woman in household arts is more than an uplift to the immediate present: it is the way of safeguarding the future. The workman's wife, untrained herself, cannot educate her daughter.

We can go far beyond any single class. The women of America of the present generation are, as a whole, untrained in the one vocation by which they can give the greatest efficiency, — the vocation of home-keeping. They are especially deficient in the most important art in that vocation, — the art of cookery. We are escaping from that well-worn myth which still declares that the only place to train the man is in the workshop, to train the woman is in the home. Half a century ago we were a nation of individual homes, and could show great numbers even of city housewives skilled in household arts. To-day it is the exceptional city girl who has the opportunity at home to obtain more than a fragmentary training in the one profession above all others which she is likely to pursue. The new vocational school, which trains girls to cook, to understand the choice of foods, and to unravel some of the thousand problems of household economics,

is doing a work heretofore omitted, at a tremendous cost, from the scheme of education.

Conferences on the industrial training of woman, the establishment of new industrial schools, the enlargement of old curriculums to include instruction of an industrial character, all show a striving unrest which will inevitably pierce the clouds which hang over any new educational movement. As some one has wisely said: "Systems of education, conceived hundreds of years ago by celibate monks for the training of men, will not suffice for the training of the wives and mothers of the twentieth century." In that utopian day when the city recognizes that money spent in teaching its girls the arts of the home brings back direct dividends in the efficiency of the men who are its workers, we shall find a whole series of schools, fitted to occupy certain definite places in the uplifting forces of the community. Each of these may be found, at least in its beginnings, to-day. Some of the women's colleges are already training teachers and social workers, who are to be missionaries in the field of true domestic reform. Here and there may be found secondary schools which are teaching womankind to bring homes into being where skill of brain joined to

skill of hand may send forth well-nourished, efficient men and women into the battle of life. Occasional trade-schools are meeting the needs of those girls who must earn, and whose families are unable to support them through secondary schools. Few of the trade schools proper limit themselves to training for a definite trade. In most of them the girl has such instruction in domestic matters as enables her to care for her own home and cook her own food, — great aids to healthy, pleasurable existence. Such education gives permanent assets to every pupil, for these arts are of value to any woman, both during her wage-earning life and when she is laying the foundations for happy family relations after her direct wage-earning existence is over.

One great hope of those who look for the endurance and success of our republic lies in the power of the nation to assimilate vast hordes of immigrants by means of conscious and unconscious education. What type of conscious education could do more than vocational schools to train the immigrating, illiterate woman in the possibility of using the opportunities about her? Our modern hurry tends to break down the women quite as much

as the men for whose domestic welfare they are responsible. The woman-worker who, because of her ignorance, subsists on tea and toast, who becomes as much a slave to her coffee as any man to his dram, as well as the woman who, because of ignorance, lives in constant terror of her servant's departure, will disappear before the oncoming knowledge of the new training. Amazing as are the numbers of women employed in a thousand varied occupations, those employed as keepers of the house and of the home far outshadow and, so far as human foresight can foresee, must always outshadow, all the rest. The efficiency which the foods of the city can give, must spring, in the last analysis, from the power of woman.

The municipality may do much in providing a training for women which shall raise the home-standards of food ; but that, at best, is a long process. It is entirely possible that employers of labor can do more immediate good of the kind that produces immediate returns, by considering the opportunities for increased efficiency that are open to community-kitchens. The provision of model factory-luncheons is a very different matter from the

provision of corporation-owned houses. The factory-luncheon is an open competitive business, which attracts only because it gives greater value for the same money than the employee can get elsewhere. It may be made of great value both as a source of energy and as a model. It is a very serious matter for a man to lose his home and his employment simultaneously. It is of no great importance for him to lose his luncheon with his job. It is a very costly affair for employers to house their workmen. It is a minor expense for them to provide excellent luncheons at cost price. A word of an experiment made along this line by one of the earliest and greatest of American scientists may be well worth consideration.

To find the genesis of reform in the problem of the food of the community, we must turn back more than one hundred years, to that North Woburn 'prentice-boy who became soldier and philosopher, diplomatist and privy councilor, and who, at the height of his career, ruled the Kingdom of Bavaria,—Count Rumford. A possessor of autocratic power, he was able to carry out one of the most sweeping experiments in practical philanthropy ever attempted. On January 1, 1790, by the use

of both civil and military power, Rumford gathered in one mass the whole body of beggars about the capital of the kingdom, sweeping them together like a school of fishes in a net. Having brought them together, he determined to reform them, and decided to do this, as he says, "Not as in the usual method of philanthropy, making people virtuous and then happy, but rather happy and then virtuous"; and this because "it is most undoubtedly much easier to contribute to the happiness and comfort of persons in a state of poverty and misery than by admonitions and punishments to improve their morals."

Of Rumford's various steps to accomplish that end, the one which most concerns us here was the success of his community-kitchen. He changed his beggars in six years from being a drain on the state, amounting to thousands on thousands of florins annually, to an asset which produced a considerable net profit after expenses of every kind had been deducted. The chief element in Rumford's success was undoubtedly his development of industrious habits where before had existed habits quite the opposite; but next in importance to that he himself placed the triumph of the commissa-

riat. By careful experimentation, he was able to feed his beggars with wholesome, attractive, and satisfying fare at a low general cost.

Rumford worked in the dawn of scientific discovery, peering ahead into unknown land where no explorer's feet had trod. To-day we find but slowly gaining ground the recognition of the employer that his well-fed, well-housed, happy workman is a source of direct profit. Eleven decades have passed between Rumford's practical recognition that the well-fed man produces most, and the welfare betterment work of the great factories of the present day: a century filled with endless experiments along moral and charitable lines, with but little recognition of one basic fact,—that the worker can be made far more productive by improving his environment.

The model factory of the present day should attack the question of community-food by the aid of all the data at command. Its welfare work should be a recognized department, entitled to support as much as its selling department; and whatever else the social workers do, the problem of food should not be forgotten. The old noon-lunch taken from a tin pail, containing cold coffee, white-livered pie, and

hunks of ill-baked bread, persists in most of our factories, but here and there can be found one where the noon hour means long white tables and hot, nutritious food, at a minimum price. The daily lunch of such a factory does far more than supply that single meal : it sets a new standard for the home. The workman who finds good food at the luncheon-table is very likely to desire it for his other meals ; and the follow-up system of the factory's welfare department should meet that desire by cooking and housekeeping lessons for the wives and daughters of the workers, which may be given in classes and in the homes. The eagerness to learn on the part of many is pathetic, and the good influence of a single factory luncheon-table may spread over a whole community.

That lunch-rooms for employees can be made practical under varying conditions has already been shown by no small number of employers. The Waltham Watch Company of Waltham, the Westinghouse Companies of Pittsburg, the Curtis Publishing Company of Philadelphia, and many others have done much experimental work of value. The manufacturer who recognizes the difficulty of the problem and yet desires to solve it will find

value in the five questions formulated by the National Civic Federation in its Conference in Welfare Work held some time ago. These follow.

“In establishing lunch opportunities

“1. What is the first practical step?

“2. Should the company take the initiative or encourage and await suggestions from the employees?

“3. Once established, should the lunch facilities be carried on by employer or employees, by both, or by an outsider?

“4. Should employees pay for all lunches?

“5. To what have the many failures been due?”

If the individual employer uses those questions and makes the matter personal by amending that last question to read

“What can the failures of others show me as to methods I should avoid and other methods I should pursue?”

he will at least have a groundwork on which to build.

So many urgent interests engage the attention of our agencies for social reform, that careful determination of the food problems of

the city, followed by systematic instruction in the methods best suited to individual cases, is rarely found. One personal episode showed me a possibility of greater accomplishment than I had ever seen before. I had spent the evening among the varied activities of St. George's Parish in New York, and my conversation with some of the workers was nearly ended. The old question of fitting the instruction to the individual arose. One turned to another. "How about your new idea in that direction?" We turned to hear the reply: "I am trying to work out a course which will give the girls the most nutritious, least expensive, and most easily prepared meals that can be cooked over a single gas-light in a hall bedroom." There you have it epitomized. Thousands of girls living in New York on the barest living wage; morning and evening meals that must be had; the gas-burner as the only means of heat. There were the factors. The problem must be solved by their use.

The community-kitchen, in theoretical rather than in practical form, still remains a burning question in our households. The servant class is diminishing in quantity and in quality. The influx to the crowded city con-

stantly increases. The number of tired housewives chained to the weary routine of seemingly endless tasks seems all too great. Why has not the community-kitchen proved the way out? One reason may be that many such experiments have begun at the wrong end. Most of the community-kitchens which have lived and failed have been started among the comparatively well-to-do, who had a considerable privilege of choice. There seems to be no apparent reason why the tremendously overburdened factory-worker's wife should not receive such a kitchen with quite as much welcome as her richer sister. From the successes which the welfare workers of the factories have gained in their attempts to initiate food crusades, the opening of community-kitchens for the operatives' families of some of the great manufacturing plants should not be utopian. One thing is sure: Count Rumford's conception seems plausible. It is difficult to amuse, reform, and educate the man with an empty stomach. It is easier to do it with the well-fed individual.

The making of food all that it should be involves many complex problems of sociology and natural science. One of these problems

seems solvable to-day by specialized education, by the training of the women of the great city and of the village, of rich and of poor, in household arts. The solution of the rest of the problem must depend primarily on two groups of workers, — on the investigators in the laboratory, whose untiring researches are gradually reducing dietetics to a science, and on the public spirit of societies and corporations which stand ready to make this further effort, to take this next step in the betterment of life to the individual. From all these agencies may come, in time, the realization of our purpose, — increase of the total efficiency through the individual's gain in power.

V

CITY WATER AND CITY WASTE

ON the Campagna, still dominating the soft Italian landscape, stand the great aqueducts by which water was brought to the imperial city. In the time of the Roman engineers, the necessity of an adequate supply of water was recognized; yet even to the present day, quantity of water has been the first step, and quality, when considered at all, the second. In no place has this condition been more apparent than in the United States. England, by her wide-reaching systems of great reservoirs fed by the waters of small streams; France and Austria, by their mountain-spring supplies, necessitating hundreds of miles of aqueducts, trailing their way from the upper slopes through meadows and vineyards to the towns and cities; Germany, with her enormous purification plants for treating polluted river waters, — all have taken more national interest in the problems of public water-supply than has the United States. In this country there are many

excellent water-supplies, but there are many others still existing in a most imperfect state, furnishing with every gallon of water the possibilities of disease.

Great bodies of men have concentrated in the cities during the last half century. With this concentration centres of population have emerged from the condition where every man's water-supply was his well, his sewage-plant the cesspool in his own yard; and, with many another collective change, we have come to a common source of water and a common disposal of sewage. To guard the purity of the common water and to insure safe methods of sewage disposal is a great task, for without such guardianship, grave and deadly danger is at the city's side. A single failure of this sort may well recall the gravity of the problem.

In April, 1885, the town of Plymouth, Pennsylvania, contained some eight thousand men, women, and children. The general health was excellent, and the water-supply, from a clear mountain spring far above the town, seemed unusually good. Like a whirlwind came the plague. Out of that eight thousand, eleven hundred and four contracted typhoid fever, and one hundred and fourteen died. Rich and

poor alike were taken, and through every part of the town, highlands as well as lowlands, the fever raged. And this terror came from *a single case of typhoid*, brought back from a great city whose polluted waters caused the fever. This case existed in one of the only two houses that could contaminate the water-system. From this source came the decimation of the little town far below. The story of such water-borne epidemics as this, and the solution of the problem of prevention by the sanitary engineer, form one of the most fascinating chapters in the never-ending war against disease.

Disease is ordinarily caused by preëxisting disease in man or another animal. Here is a bold statement that is often forgotten. Typhoid fever and Asiatic cholera from the intestinal germs of former cases, scarlet fever and measles from the skin-excretions of convalescing patients; yellow fever and malaria through the mosquito in which the disease-germs pass a portion of their life, — case after case of the truth of this theory might be cited. Moreover, if we accept the germ theory of disease, we must believe that many classes of ailments owe their origin to certain definite micro-or-

ganisms, each of which belongs specifically to a separate disease. It is well known that these bacteria, entering the body in sufficient number, find there a comfortable lodging-place where they may grow and multiply. A peculiarly favorable ground for the cultivation of certain of these micro-organisms is furnished by the alimentary canal. Water is the chief substance to pass through this channel. Typhoid fever and Asiatic cholera are water-borne. Water, pouring from the hillside down to the lake or river, has no selective power by which it can avoid carrying on disease-germs in its path. Evidently, it is of vital importance for us to know the possibilities of disease in water, and how prevention may be secured.

Of all possible sources of bacterial infection of water, sewage stands easily first. Sewage, the collected organic wastes of community life, is the home of myriads upon myriads of bacteria. With the necessity for a common sewer has come the problem of such a disposition of sewage that there shall be no possibility of admixture with the water-supply. The coast cities can use the sea for such disposal, but the great mass of our population is inland. Large towns and cities must depend on large

bodies of water for their water-supply. The danger that these waters may contain pollution from sewage is one which should be avoided at any cost.

Each pipe and faucet bringing water into the private home or public fountain is a gate by which disease may enter, if proper safeguards are not placed in the way. Let us consider what barriers, natural and artificial, may be raised against such entrance.

Two classes of water are recognized by the sanitary engineer. Ground-water is the first, in which class ultimately belongs the great body of atmospheric water falling to the soil. This water directly penetrates the interstices of the surface-earth, and sinks to a greater or less distance. Surface-water, on the other hand, is that water which strikes non-permeable soil, and rolls from rocks or flows from clayey earths directly into streams or ponds. These larger bodies, as well as their visible supplies, are also called surface-water, although they are fed to a large degree by groundwaters from below. It is in the water on the surface of the earth that one finds the chief source of peril. The rushing stream or quiet brook gathers the various impurities along its

road and disseminates them as it passes on, while, to add to the difficulty, other pollution may come from industrial and organic wastes sent forth from factory and town along the shore.

Ground-water, as it passes into the earth, receives a natural filtration marvelously thorough in its action. In this straining and cleansing of the water entering the soil we find the first of the natural barriers placed against the foe. A porous earth is a storehouse of bacteria; the richer the soil, the more fertile and open the ground, the greater will be the multitudes of bacilli spread to an indefinite extent throughout its masses, since here are found all the advantages to foster the life of the germ, — darkness, moisture, and food. As the water passes down through layers rich in micro-organisms, some filtration proper undoubtedly takes place. Important for purification as well is the fact that the bacteria in its path rob the traveling liquid of its organic matters, the food of the germs. This action is so effective as soon to make bacterial existence impossible. In consequence, the purity of the ground-waters is marked; and when taken from deep cavities, by means of

driven wells, they make a serviceable type of water-supply. A possible hardness from dissolved inorganic matters, and a tendency to develop vegetable growths under the action of light, are two difficulties with such a source. Far more serious, however, is the fact that such a supply in most cases is small in amount, owing to the slight extent of the natural reservoirs.

The limited supply of ground-water has forced the great mass of communities to the use of surface-water. With this source the first point of defense must be the control of that territory from which the supply comes. No point in the chain of defense against the invading germ is of more importance than complete control and proper supervision here. The results of overlooking this necessity have already been noted in the case of the town of Plymouth; and widespread epidemics have often come from a single source of infection on the watershed. In Germany, England, and America it has repeatedly happened that in towns with two sources of supply, one pure and the other impure, those who used pure water have escaped, while those who used the polluted liquid have perished. More thoroughly

to safeguard the Metropolitan Water-Works System in Boston, for instance, neighboring towns and cities, whose drainage might even remotely affect the water furnished by the system, have been obliged to install sewage-disposal plants.

Geological conditions and the natural slopes of the land prevent many cities from using still waters collected in reservoirs or impounding basins, and they are forced to resort to more or less polluted lakes and rivers. Even under this necessity, how has it come about that so many water-supplies are taken directly from polluted sources, without a single cleansing of the raw water? The answer in many cases must be that such systems were installed during the prevalence of the theory that "running water purifies itself." This theory was based on the fact that fouled running water soon became bright and clear. The chemical analysis showed that less organic matter was present at the lower than at the higher point where wastes had entered. Moreover, the slight knowledge of bacterial water examination of that day was insufficient to show that the germs of disease had not disappeared between the two points to the same extent as had the other organic matter.

On the contrary, it is now known that storage water-systems which keep potable water for periods of time in lake or reservoir have a purifying tendency. This purification is due to the fact that parasitic bacteria in the low temperature, the sunlight, and the scant food-supply of a reservoir or lake where organic matter is practically absent, have at best a struggle for existence. Many must succumb, since disease bacteria of the water-borne varieties are adapted to the warmth and moisture of the alimentary canal. Such germs as these, accustomed as they are to an easy existence, die when brought into conditions where hardier organisms might survive.

Storage is sometimes impossible to attain. Communities must occasionally depend on river waters at their doors. Yet no town placed on a river-bank and unable to obtain long storage need be forced to use polluted water or lie defenseless against the bacterial assault. One safeguard stands preëminent to-day: the filtration of water under conditions which remove not only its turbidity and color, but even much of its bacterial life as well. Water-filtration proper, as opposed to sewage-filtration, is a mechanical operation, a straining out, not only

of dust and dirt, but also of the infinitely small inhabitants of the liquid, these inhabitants being such tiny living organisms that tens and hundreds of thousands of them may float unseen in a teaspoonful of water. Let us journey through the chain of fortifications used in the treatment of water by a system of continuous filtration.

To remove any grosser forms of residue, such as gravel and waste, the raw incoming water, known as the affluent, is turned into a great reservoir with massive sides, called the settling or sedimentation basin. Here the liquid is allowed to remain until the impurities which would clog the filter have settled. When this has occurred, the upper layers of the water are drawn off into the filter proper, a great basin made of masonry or concrete, underdrained, and with an exit pipe at the bottom. This basin is filled with fine sand above a gravel layer, which in turn is supported by rock underdrains. The sand acts in a double capacity. The spaces between separate grains of sand are ordinarily less than $\frac{1}{8}\frac{1}{2}$ of an inch in diameter, so that the passage of all but the finest particles is prohibited. The bacteria would pass even through here, were it not for a second ser-

vice of sand, which acts in a most remarkable way as a support for a true bacterial filter. As the affluent passes through the upper layers, the sand stops the coarser materials left in the liquid and held in suspension there. Soon there forms above the original surface a filter composed of the smaller sediments, a layer so fine that even the infinitely small micro-organisms cannot pass. Many of them are probably held by the sheer adhesion of the sand. Add this adhesion to the filtering powers of the sediment layer, and you have erected a strong barrier. Here is a fortress placed across the pathway of the invading germ, a barrier so effectual that water from sources polluted with disease-germs has been safely furnished to thousands after such filtration.

The sediment-filter is, of course, constantly increasing in thickness, and as it increases, more and more pressure is necessary to drive water through the interstices. When the point is reached where the pressure required to force the water through is too great to be practicable, the surface of the filter is scraped. Since during this scraping the filter has to be out of commission, filter-plants are generally built up from a series of small filters, in order that

one or more may be out of use at any time for repairs. Filters may be either open or roofed, the covering of the filter-beds depending to some degree upon geographical location. The North requires covered filters, while the South gets along very well with open ones, the chief difficulty being due to ice-formation.

Besides the continuous filter described above, one other form of filtration is commonly employed to-day, — the mechanical filter. For the last ten years the growth in number of plants of this type has been most remarkable. The mechanical filter differs greatly from the continuous filter. It delivers from fifty to one hundred times the quantity of water, and is correspondingly reduced in size. A single continuous filter may occupy an acre, while half a dozen mechanical filters may be installed in less than a quarter of that space. The former device recognizes as a cardinal principle the keeping intact of the surface of the filter where the bacterial life is strained out in the close upper layers. The latter accomplishes its work by the addition of a chemical, whose action on meeting the water is such as to engulf all matters held in suspension, including bacteria, thus forming comparatively large

masses, which can be filtered without difficulty. The chemical commonly employed in the mechanical filter is sulphate of alumina, which, when added to water, separates into sulphuric acid and alumina, the latter being a flocculent cloudy precipitate which spreads out over the water. The heavy precipitate thus formed settles down upon the sand, and, acting like a sediment-layer in the continuous filter, removes the germs. As with these large masses the clogging tends to stop the flow, the sand at brief periods is washed and stirred, with removal of the former residues.

Now as to household filters. What can we do in the private home to stop the entrance of the disease-germ, provided we believe danger exists? The sanitary experts say that no small filter which allows a good stream of water to pass removes bacteria. In the sale of such filters and the belief in their efficiency lies peril to the public, who so often believe that a couple of inches of sand or charcoal preserves them from all harm. As a matter of fact, expert engineers are practically agreed that eighteen inches of sand above drains, and that well covered with the sediment-filter, are necessary to obtain efficiency. Some of the

larger household filters are efficient when filled with fine filtering matters, such as sandstone and infusorial earth, which only allow water to pass drop by drop. These are usually either provided with storage-reservoirs, or joined in a series of filters so that a quantity may be obtained at once despite the slow rate of filtration. One simple safeguard is always at hand, and should never be forgotten, — the boiling of the drinking-water. No precaution is better in time of epidemics. One point should be made clear, — individual protection can never possess a fraction of the value that belongs to municipal control, any more than the individual fire extinguisher can compete with the city fire department.

The teeming thousands in the narrow ways receive one common food, the city water. We have already considered the way in which it may be delivered to all, pure and free from dangerous burdens. We must now consider the other side, the outgo of the city. Every organism, as a condition of its existence, must be forever building up and breaking down. Life depends upon the proper balance of the constructive and destructive forces of nature.

From the decomposition of the organic foods and various materials used in our complex life, from the sweepings of the streets and the discharges from houses, factories, and shops, comes the outgo of the city, its sewage.

The sewer is the abiding-place of good and bad bacteria, five million or more of which may make their home in a single thimbleful of liquid. In the sewer they find darkness, moisture, and food. There they thrive and multiply. Possibly as important as the number of evil micro-organisms found there is the certainty of the presence of deleterious organic matters which, in their present state, and in their changed form after decomposition, are products dangerous in themselves and noxious to all around. We have hitherto considered chiefly the removal of bacteria of disease; but we must here consider as of primary importance the elimination of the harmful elements of the city wastes.

The realization that sewage, unless properly purified, might be a danger to the community is a matter of comparatively recent growth. In 1815 London used her sewers only for rain-water, and disposition of other matters therein was forbidden. Here and there in isolated

cases might be found early attempts at some method of disposal, as in the case of the little town of Bunzlau in Prussia, which in 1559 had a piped water-supply and a system of sewage-farming. These attempts at scientific solution of the problem were at best sporadic until the year 1844, which marks the opening of an era that recognized the necessity for proper waste-disposal. This era began with the remarkable "Report of the Health of Towns Commission in Great Britain," which for the first time revealed the dangers which might come from improper waste-disposal and the accumulation of sewage. As a result of that report arose the "Filth Theory of Disease," which, since it is not yet eradicated from the popular mind, and since under it was accomplished some of the best sanitary work of the century, needs at least a passing mention here. According to this belief, disease was bred in masses of decomposing filth; it originated there, and was in some way a product of the reactions therein contained. We now know that the main part of this theory is false, and that disease cannot originate in filth, although it does find there a convenient carrier.

This "Filth Theory of Disease" swept

through the scientific world with the most surprising rapidity. The problem of sewage-disposal became urgent in a moment, and soon the modern method of sewage-carriage, dilution with water, was evolved; and the problem became that of handling a mass of wastes enormously diluted with water, a dilution so great that in America there exists but one part of solid in one thousand of water. Disposal by dilution is in some special cases possible. It is true that where not more than one part of diluted sewage is sent into fifty of water, the oxygen of the water may be sufficient to take care of the wastes; but this proportion of water to sewage is so large that, save on the sea, on great lakes, or on rivers the size of the Mississippi, any such disposal is unsafe in the extreme, and any use of water from such a source must be a constant menace.

The first step in any handling of sewage is such a separation of the wastes that the different parts may be handled to the best advantage. The first treatment consists in screening the large floating objects which have entered the sewer in various ways, and removing all rags, bits of wood, and the like, which may be in the liquid. In Germany this treatment has

been brought to a high degree of efficiency by the use of very fine screens mechanically operated. There will still remain in suspension a large amount of gravel and other matters of that type, which have been washed in from the sewer-openings in the streets. This may be removed by checking the rate of flow, and so allowing a settling-out to take place. That leaves as the crux of the problem the disposition of the organic matter which is left. Purification by chemical precipitants, such as are used in the purification of water in mechanical filters, has been tried in the past and has proved unsatisfactory.

Before passing to the consideration of particular details, let us turn for a moment to consider by what method this cleansing may be brought about. Sewage must either putrefy or nitrify. That is, it must either decompose (with results unfavorable in the extreme), or such chemical action must take place as will change the harmful organic ingredients to simple inorganic matters, a result really effected through bringing them into contact with the air, the oxygen of which will produce the change. These organic city wastes, while most complex, and differing greatly in their

individual structure, are yet composed chiefly of but four elements, carbon, hydrogen, nitrogen, and oxygen. The oxidation or nitrification of such wastes consists in so combining the nitrogen with the free oxygen of the air as to form nitrates. This is the reaction, which is of importance to the city's health, though at the same time the hydrogen is oxidized to water, and the carbon to carbon dioxide.

The problem before us, then, really resolves itself into this: How may we so oxidize or nitrify sewage as to change the noxious organic matter into harmless mineral substances? To do this, the sanitary engineer reverses one of his processes for cleansing water. Instead of removing the germs, as in water-filtration, he cultivates myriads of helpful bacteria. Whether we consider such sewage-disposal as carried on by natural or by artificial means, on the irrigated farm or the trickling filter, we find this startling and remarkable fact: the oxidizing of the sewage is done by millions of living organisms. These tiny particles take in the organic wastes and turn them into safe and harmless inorganic matters. To cultivate such bacteria, and to use their destructive powers on dangerous elements, has been the

effort of all recent sewage researches. How they are accomplishing this task may be told briefly here.

The oldest form of sewage-disposal is the disposal on land for use as a fertilizer. For more than four centuries the sewage-farm has been an attractive conception to students of possible economies of the state. Berlin and Paris have both had farms of this kind for years, and many other experiments along this line have been made here and abroad.

On soils even moderately fertile the sewage-farm seldom pays, costing, despite returns, more for its maintenance than other types of disposal-systems. It is on soils like those of the West, where the water carrying the organic matter is of value for irrigation, that sewage-farming has been made to pay; and there is every reason to believe that in such a region it could be made a most profitable municipal investment.

The fertility of any soil is greatly affected by the bacterial action which goes on in its upper layers. The bacteria on the soil of sewage-farms are the oxidizing agents, taking in the organic, and sending forth inorganic, matters at the end of the reaction. As the fertility

of the soil increases, the effectiveness of the plant to nitrify the sewage increases as well, but one precaution must be taken in any use of sewage for fertilizer. No crop should be raised which is to be eaten raw, and preferably no crop intended for human consumption. A notable example of successful Western sewage-farming is shown by Pasadena, California, where walnuts, a crop safe from bacterial infection because of their shell, and free from all clogging of the porous soil, have been grown with profitable results. A substantial profit has been made year by year, and from the surplus the original cost of the land is rapidly being paid off.

Leaving this natural process, we come to the processes evolved by science. By 1865 it was recognized that the essential factor in the purification of sewage by means of land was the bacterial action upon the organic wastes. Early investigators had some inkling of the fact, and had proposed a system by which, through the special cultivation of the destructive germs, a rapid purification might take place. By passing the organic wastes of a community, with their accompanying micro-organisms, through great masses of destruc-

tive bacteria of the proper type, these waste products might be broken down, the living organisms destroyed, and the harmful elements removed. A tremendous conception, this enlisting of armies of good microbes to fight the hosts of evil! This theory has directed the scientific attack on the problem for the last thirty years. Given the possibility of such action, what method could best carry it out?

In 1887 conditions in Massachusetts had become so serious that there was instituted by the State Board of Health an experiment station at Lawrence for the study of sewage-disposal and water-supply. It was put under the charge of Mr. H. F. Mills, with the coöperation of Professors Sedgwick and Drown of the Massachusetts Institute of Technology. At that station were carried out the classic Lawrence experiments.

In these researches ten different filtering materials, such as gravel, sand, loam, and the like, were placed in ten experimental tanks, and the same sewage was passed through each. Continuous and intermittent filtration was tried, and the number of bacteria present before and after filtration was most carefully determined. As a result, the great principle

was established that purification is an oxidizing process carried out by bacteria living in the filter, and (a most important result) that a rich supply of oxygen is necessary for their activity. The process of action with oxygen is known as the "breathing of the filters." It was early found that in sewage-filters, like the continuous water-filters, there was not sufficient opportunity for the bacilli to obtain enough oxygen to oxidize the organic matter passing over. In consequence it soon became evident that maximum efficiency would be obtained only when — the filters having been once filled with sewage — the bacteria should be allowed to act upon it with free access to the oxygen of the air. This intermittent action, the addition of the sewage followed by the addition of supplies of oxygen, is a battle in which the foe is met by a defending army whose ammunition is constantly renewed.

The principle of the intermittent filter is found in the other modern devices by which bacteria meet bacteria in deadly battle. The contact-bed system, used in England, is found but rarely here. In this system, the liquid, instead of passing through the filter of sand, is let into a great tank filled with coke or some

hard, smooth material ; this is then filled with sewage and closed. The sewage is allowed to remain there for two hours or more. During this time the bacterial films upon the rocks absorb organic matter and bacteria, and at the end the remaining liquid is discharged. Oxygen is thereby allowed entrance to the films, and the bacteria do their appointed work as scavengers. By careful regulation as to the time necessary to accomplish the results, it has been claimed that satisfactory purification may be obtained ; but extreme care has to be taken in the control. Some decomposing action also proceeds during the period in which the sewage is in the tank. Action of this type will be considered later in a paragraph on the septic tank, and need not be considered here.

The third type of disposal is still simpler in principle. In early experiments with intermittent filtration, air was forced in from below to allow for the breathing of the filters. Soon the necessity for more air, for increased supplies of oxygen, made further experiments along the line of intermittent filtration necessary. In the trickling or sprinkling filter it was first made possible to treat sewage with a continuous supply of air. In this process, by

one means or another, — the tipping of small buckets or splashing from sprinklers, — the sewage is constantly passing into a filter filled with coarse gravel. As it trickles down between the openings, it carries with it air for its own destruction. Oxygen is also obtained from the open construction of the filter, which allows constant air-communication between the interstices. The bacterial films upon the stones absorb the organic matters and new bacterial life, as in the case of the contact-bed; and through the constant breathing of the filters the oxygen necessary for the burning up or oxidization of the wastes is secured.

The action of the intermittent filter and the possibilities of its use can be expressed in no way better than by quoting the brilliant ending of Mr. Winslow's article on this subject: "The trickling bed appears to be the ideal method of solving the essential problem of sewage-disposal, the oxidation of organic matter. It exhibits the simplicity of all scientific applications which are merely intelligent intensifications of natural processes. A pile of stones on which bacterial growth may gather, and a regulated supply of sewage, are the only desiderata. We meet the conditions resulting

from an abnormal aggregation of human life in the city by setting up a second city of microbes. The dangerous organic waste-material produced in the city of human habitations is carried out to the city of microbes on their hills of rock, and we rely on them to turn it over into a harmless mineral form."

To produce a still greater bacterial cleansing, the effluent, or outcoming liquid, produced by these processes may be rapidly filtered through a second filter of sand, or may be sterilized by the use of the chlorine of bleaching powder. The development of this latter chemical process for the purifying of water has proved one of the most interesting developments of recent years. It has been shown that the chemical disinfecting of water gives a very high degree of bacterial purification at a very low cost. In fact, the entire water-supply of Jersey City, N. J., has been treated in this way for over a year. Properly controlled, there seems to be no evidence that the addition of the bleaching powder in any way injures the water.

Such a process should be excellent for high-grade supplies, where it is desired to remove even traces of impurities. It should be espe-

cially satisfactory with good unfiltered water from protected watersheds. It has scarcely been definitely proven as yet that it provides an unfailing method of purifying polluted waters.

The processes of nature have much to do with any water-supply, and the rain falls in greatly varying quantities at unexpected seasons. A sudden rush of rain washes in quantities of solids and produces a largely increased bacterial content in any water-supply. Where there is any possibility of sewage reaching the water, pollution will be far greater in wet than in dry times. An amount of bleaching powder which would be quite sufficient to cleanse water on, for example, 363 days in the year, might prove wholly inadequate on the 364th or 365th. Unless a great excess of the purifying agent is added constantly, there will be unusual days which might prove times of peril. Under no circumstances should any community be obliged intentionally to drink sewage. A water-supply which has been purified by the best methods known to-day is the right of every citizen.

One last method of bacterial destruction of sewage must be considered here — the septic tank, the successor of the individual cesspool.

While impracticable for final disposition, it has a decided value as a preliminary step in the treatment of certain concentrated sewages. The principle of the ordinary cesspool depends upon the fact that a large part of the solid organic wastes are acted upon in the closed dark receptacles, without access of air, by bacterial ferments, and are turned into liquids which may be drained off, or into gases which may escape. Such solid portions as are unaffected by this change may be removed a couple of times a year. In the modern form of septic tank the wastes, instead of being left to be acted on for a long period without the use of oxygen, are run into a close tank, where they are left for about twenty-four hours. During this time, the chief decomposition has taken place, after which the residues are pumped to the filters or contact-beds, where the final oxidation may occur by means of the oxygen of the air. The septic process does not produce a pure effluent, and it does not effect bacterial reduction to any important degree. It is simply a method of reducing solids as a preliminary to some form of biological purification. It is, however, a useful device in its proper place.

We have already considered the use of the household filter in some detail; but the general problem of good water and safe sewage appeals to every owner of a country house, and a few words on this subject should be inserted here. The best soil for these purposes is a sandy one, and wherever a rocky or clayey soil gives possibility of a fissure which might connect water and drainage, expert examination should be called in. The individual plant for water and sewage may often be a well and a cesspool — the cesspool, once a boggy to sanitarians, being now justified by the septic tank and the sand-filter, both of which principles are employed in its construction. Two points must be recognized here. First, such a covering of the well that the grave danger of surface pollution may be avoided, for it is most essential that no pollution should be washed through covering boards. Second, care with regard to the direction of drainage. This is generally toward the nearest water-course, and must be such that the water-supply may not be below the point of sewage-disposal. With these simple precautions of investigation of soil, covering of well, and proper location of the direction of drainage water and the source of

drainage, the isolated country house-owner may feel secure.

As we look over the whole field of effort, the striking factors of present-day progress in bacteria-removal and sewage-disposal seem to be taking on definite specialized form. The engineer is tending to use one method for water — the removal of evil bacteria by filtration. He is using largely a different method for sewage — the cultivation of good bacteria which may render safe the city by their removal of its dangerous organic wastes. Removal of the evil and cultivation of the good! The most highly specialized forms of water and sewage-filters show this best. The mechanical water-filter has chemicals to separate out the bacteria, pneumatic arrangements to wash out the sand, and casings of concrete for protection from the air. The sewage-filter, on the other hand, is, in its essentials, nothing more than a pile of rock on which the good bacteria may grow. The future advance of sanitary science seems likely to be along these lines. More and more dependence is placed upon research, and the real importance of the problem seems daily more manifest. The careful experiments at the Columbus Experiment

Station in Ohio, as well as the noteworthy results obtained by the Sanitary Research Laboratory which has been established by the Massachusetts Institute of Technology, show the trend of progress.

To make the city habitable, to increase the efficiency of the state through the better health of its citizens — what task is higher than this great labor for the common good? On the man in control of the water-system or the sewage-plant rests the success or failure of many measures planned for the public weal. In the solution of that great problem in applied science, the government of the city, no man must bear a greater responsibility than the sanitary engineer.

Such civic interest should be awakened in every community as will demand that the guardians of our public health shall be rightly trained, wise, and free. Above all *free* — since freedom from political control, from jealousies and narrowness, must be secured in order that full power may be given to the guardians of the public health to keep up the fight until the day when final conquest comes.

VI

ICE

STRAIGHT from the north sweeps down the icy blast, cresting the snowy mountain-top, clearing its rugged barriers, and swaying to rhythmic pulsations the pines along the borders of the lake. Day after day the winds bear down increasing burdens of cold. Hour after hour the ice-crystals sink deeper and deeper into the depths below. Then, when the leaden skies are bordered with dull northern gold, figures of men advance upon this natural stage, whose background is the majestic mountain, whose wings are forested with white-capped green. The stillness ends as workers, in gay blanket-coats or heavy corduroys, harvest their winter store, cut out huge squares upon the surface of the lake, trace and retrace their steps, moving like living chessmen in steps of knight or queen. The cold wind of the open north congeals the ice. Hot, dust-filled city winds return it to its liquid state once more. Whatever the purity of the source, the sum-

mer days, when the ice-cars reach the city, see this common food thrust out on dirty platforms through dirty chutes, thrown into wagons which stand open and exposed to the dust of the city street. Nor does delivery at the door end the possibility of contamination. Solid water may turn to liquid water in unclean refrigerators, cool the refreshing drink of car, of office, or of street, in positively filthy water-tanks, or become infected by the hand of its server. Make a personal experiment: look at your own refrigerator after a hundred pounds of ice have melted, and see whether or not the compartment is clean.

Few of the topics considered in this book belong more exclusively to the city than this of ice. Food, air, and milk vary the conditions of their supply by the different requirements of the crowded street and the isolated farm. Ice, on the other hand, to-day as always, finds its chief use in the city. The cold cellar or the well still serves the refrigeration purposes of a large portion of rural America. Where ice is used on the farm, it is commonly taken directly from the individual ice-house, where it has had all the benefits which come from storage and few of the disadvantages which

come from handling. Farm food, moreover, is not only fresher and in less need of cold storage than the city's supply, but it may well be possible that the freer life of the country breeds less desire for cooling foods and drinks than does the far greater confinement of our brick-walled existence. Certainly, the city's necessity for refrigeration and for ice is beyond question. Its food, brought from long distances and often unnaturally preserved by storage methods, must be chilled to be healthful. Its children, wearied by the nervous exhaustion of the streets, have a real need of the tinge of attractiveness which cooled viands provide, to obtain a sufficient nourishment.

No other nation can compare with the United States in the consumption of ice. Its use in the Orient is limited chiefly to the foreign settlements and the selected upper classes; while in Europe, though it is used for cold storage, its service as a food is relatively small. Even where modern custom and the inroads of American travelers have made its presence an every-day affair abroad, the cooling drink is offered the diner, but not forced upon him. The waiter presents the glass bowl of cracked ice for acceptance or rejection. In America

we have no choice. If the carafe is not full of water frozen in its place, the glass of ice-water is surely present at your elbow. Slight indeed is the probability that we can diminish the city's call for ice, however loud the annual outcry against its use. Granting that the demand is unlikely to subside materially, let us, in order to determine what the situation really is, consider, first, how the purity of ice is affected by its formation, second, the possibilities of its contamination during harvesting, sale, and use, and, third, the way in which the present-day conditions of the ice trade concern the dwellers of the city.

City ice comes from one of two sources: it may be produced naturally in river, lake, or pond, or it may be manufactured artificially by what, for want of a better name, we may call cold-storage methods. The formation of natural ice is, in itself, one of the strangest of the thousand disregarded phenomena of natural life. The basic causes of that example of the craftsmanship of nature known as crystallization, of that property of matter by which solids group themselves in the fairy traceries of the snow, the gleaming facets of rock crystal, or the huge pillars of the salt

mines, lie deeply hidden. The effects of that craftsmanship we know, and of those effects few are stranger than the selective process which goes on in crystalline formations. Those tiny particles which make up the regularly formed crystals are able to pick and choose their associates, and refuse to accept for the structure of their walls substances unlike themselves. This is a general rule which governs many forms besides the special one under consideration. Crystalline bodies in solution in the foulest liquids crystallize out in a state of purity so great that analytical chemistry constantly takes advantage of this principle to obtain strictly pure materials. Ice-crystals, forming, will build nothing into the icicles save water. The effect of this natural selective power has a close bearing upon our subject.

Every lake or pond is a great bowl holding in solution and suspension many solid particles, such as the tiny bacterial plants which inhabit its depths, the refuse of the shores, and portions of the solid matter of the bottom. When the falling mercury plunges below the freezing-point, the contents of these huge bowls suffer a sudden change. Tiny six-sided crystals shoot forth upon the surface, join side by

side, and take up so much more space than the water from which they come, that the expanded ice is often thrust up upon the banks. If substances like straw, chips, or refuse are floating on or near the surface of the water when the change takes place, such solid bodies will be imbedded, mechanically caught, between the crystals, in the same fashion that a ball is caught between two clasping hands. There is the first possibility of ice-contamination. A considerable amount of light straw and refuse is likely to be floating upon or near the surface. The greater part of this, good and bad, pure and impure, is entangled in this upper sheet.

Below the surface of the liquid quite another condition holds good. The ground at the sides and bottom is a non-conductor of heat. In consequence, ice can form only at the top, and the solid mass must grow vertically downward from the surface. As the cold increases, the tiny crystals, forcing their way through the water, shoot towards the bottom like icicles on the eaves of a house. Each pointing icy finger, as it pushes its way downward, constantly rejects all other substances besides water, forces floating bacteria and other

solids steadily back, builds water and only water into its structure. Since the whole mass is made up of millions of individual crystals, those solids, and only those solids, which are mechanically entangled between these individual crystals appear in the final cake of ice. Such impurities are comparatively few below the topmost crust. In consequence, the greater part of the ice is cleansed by this process. The old theory that "frozen water purifies itself" is true so far as crystallization *below the surface* (notice those three words) is concerned.

Crystallization is not the only mechanical factor which tends to clear ice from impurities. Once the cold lake is covered with its glittering shield, the water below is no longer ruffled by the wind, and is practically undisturbed by the changes in weight due to expansion and contraction. Under such circumstances a lake or pond tends to become a still pool in which all floating matter which is heavier than the liquid in which it rests is persistently pulled downward, is constantly sinking toward the bottom. To state it in a different form: once the water's surface is chained in place, the never-resting force of gravity, then unopposed

by many resisting forces, such as wind and wave, goes steadily to work to pull the solid matter in suspension away from the upper layers of the liquid into which the ice is extending. The tiny micro-organisms which are responsible for water-borne disease are slightly heavier than water. They are borne down also. The force of gravity, which drags them down, works with crystallization to free the lower portions of natural ice from its impurities.

The floating matter of the surface makes but one portion of trouble. Men and horses, passing over the ice in harvesting, track in no small amount of dirt of various kinds. If the ice is harvested from ponds below the snow-line, dust-filled winds from neighboring streets may cover it. If it comes from lakes near manufactories, refuse from the plant may be blown out upon it. If snowfalls and slight thaws come, the snow and ice, melting together, produce snow-ice, the white opaque form known to all. Snow is by no means a welcome addition. It holds readily all solids which fall upon it, and, crystalline as it is, falling snow serves as a filter to the air, entangling and enmeshing bacteria and dust as it falls from the heavens to the earth. Snow-

ice is to be avoided. The upper crust of ice is dangerous for use.

The conditions mentioned heretofore have been produced by comparatively normal conditions of ice-formation and of harvesting. The ice-dealer has little share in producing them. The dealer, however, can make trouble for the consumer who desires purity by joining thin sheets to form thick cakes. In mild winters, when the ponds where ice is generally cut do not freeze to a sufficient depth to give a satisfactory cake, narrow sheets are sometimes cut and packed together in such a fashion as to give a doubled cake. Under such circumstances, two upper layers with their impurities often come together in the centre of the cake, and give out their combined dirt when the ice melts.

From filth produced or preserved in some such fashion as those mentioned above comes a large part of the mud which fouls your ice-compartment, or leaves a line of black scum in your glass of water. Difficult though it is to bring a direct charge of typhoid infection against these sources, there is a perfectly reasonable probability that many cases of intestinal diseases have originated in such dirty

masses. And cleanliness in this respect is directly within the control of the health authorities of the community. Since individual consumers of ice are unlikely to be able to stop the selling of upper-layer, snow, and doubled-layer ice, the city should keep such ice from reaching the homes of its citizens. Demand that this slight layer, which contains the dirt, be planed off; let the sale of dirty ice be forbidden by enforced official act; and conditions will rapidly improve. Every consumer recognizes clear ice at a glance. Inspection is no difficult matter.

When we look over our data thus far obtained, we find many hopeful signs. It is true that the free ice of the north may become contaminated by the foreign matter of its crust, or by the burden of snow-ice; but it is equally true that two cleansing agencies are unceasingly at work, crystallization and the force of gravity. It is within the power of man to use a third, the planing of the ice. The artificial ice of the factory has been much heralded as an advance upon nature. Before passing to a relation of the researches and discoveries which bear upon our problem, suppose we compare the two.

If the ingenious Yankee who first conceived the possibility of sending Wenham ice to tropical lands could return to view the results of his handiwork, he would be amazed indeed to observe the results of the trade begun so many years ago. Once the torrid zone had tasted ice, the development of the artificial supply was inevitable. To-day, the ice-machine, its benefits long since extended far beyond the boundaries of the tropics, is used the world over where any deficiency in the supply of natural ice exists. As the problems of artificial ice are closely connected with the processes of manufacture, a word concerning these processes may be of service here.

One point should be noted here before going farther. Ammonia is much used in the production of artificial ice. The ammonia referred to in the following paragraph is not the common household ammonia. It is the liquefied anhydrous ammonia gas of the cold-storage plant. With that point clarified, we may turn to our description.

The making of artificial ice depends on the fact that certain liquids, like ammonia, turn to gases at low temperatures, absorbing heat from everything around. If you had a stop-

pered bottle of liquid ammonia in a pail of water, and suddenly released the stopper, the liquid would turn to a gas, and the absorption of heat in the process would so chill the surrounding water as to turn it to ice. This is one variety of the many natural changes which absorb heat and, in so doing, chill surrounding bodies. The commonest change of this kind that we know takes place when the ice and salt of the ice-cream freezer take heat from the liquid in the can and chill it to solid ice-cream. In the case under consideration here, if you have brine around the inner bottle, when the liquid ammonia changes to gas, instead of water, the brine remains liquid, but is so chilled that it would freeze a glass of water placed within its bounds. This second indirect method of freezing, that is, chilling brine by the ammonia or some like process, and allowing the cooling solution to freeze water, is the one employed in making artificial ice. The water to be frozen may be placed in tanks in the cold brine, or may be allowed to run continuously down a trough, bordered on each side by tubes of cold solution. In the first case, the ice freezes solidly in blocks. In the second, ice is continually formed at the sides, but the

liquid never solidifies to the centre. There is always a stream of water flowing between the cakes of ice. One point more: when the cold brine is pumped through pipes to refrigerators and warehouses, a cold-storage system is formed.

Our special interest in the artificial process has mainly to do with its cleanliness, or lack of cleanliness, as related to the methods used by nature. In general, forced freezing compares unfavorably with the natural processes already mentioned. If the water used in such manufacture is ordinary city water, the excellence of the ice will be in direct proportion to the excellence of the water. And the excellence of the water-supply should be strongly insisted upon, for the forces that cleanse natural ice can do but little to free artificial ice from its impurities. Where water is frozen from a continuous stream, gravity has little chance to purify the ice. Where water is frozen in blocks, crystallization does nothing to make the solid better than the liquid. Artificial ice, frozen in a solid block, freezes from the outside in, and remains liquid in the centre to the last. Because of this, any solids present are driven back towards the centre. In the case of natu-

ral ice, the impurities, driven downward, sink into the water below. In the case of artificial ice, after they have reached the centre, they are frozen solidly into the block. Moreover, this natural freezing inward gathers all the impurities into the centre of the block, thereby making possible all the dangers which come from concentration as opposed to dilution. Several methods have been employed to do away with this difficulty where the water-supply is questionable. One needs special mention, the tapping of the cakes (just after the final solid freezing) in order to remove polluted water. Reliance cannot be placed on any such alternative as this.

Artificial ice made from impure water must always be of dubious purity. Even where distilled water, probably the safest alternative, is used, one precaution should be taken. The stills should not contain lead pipe. The danger of lead-poisoning in ice is quite as great as the peril of similar poisoning in water. One and only one way provides safety, — freezing pure water delivered through pipes unaffected by water's dissolving powers. A former custom, now fortunately somewhat gone by, of serving raw oysters in hollowed, melting

blocks of ice, succeeded, when the artificial form was used, in laying the food at the one point where whatever infectious material might be present was chiefly gathered.

Closely related to the production of artificial ice is the growing use of cold storage, probably the best method of refrigeration yet discovered. The large markets of our cities depend almost exclusively upon systems which pump chilled brine through stall after stall and shop after shop. In these, the former custom of placing food-supplies in immediate contact with ice is rapidly changing. A number of the new apartment houses have recently provided refrigerators for their tenants, which are cooled by cold-storage systems running out from small central plants; and there would seem to be no reason why the extension of such advantages to whole blocks and streets in crowded quarters might not be practicable. It is a possibility well worth consideration.

Somewhat reversing the normal sequence, we have so far considered ice the final product. We can scarcely pass to the second stage of our argument without a word concerning water, the source from which the product

springs. It can hardly be repeated too often that the city's problem, as it has to do with water, concerns not the liquid itself, but the tiny plants which live within its depths ; that the possibility of water-borne disease arises from floating micro-organic forms. Bacterial life is lived under widely varying conditions. Even with a common environment, great diversity appears ; and the investigator of bacterial populations often finds wide variations in the numbers present in a given area, even where the surrounding conditions seem apparently much the same. Thickly clustered, living masses of organisms may appear in one part of a lake where other portions show only widely scattered individuals and minute colonies. So men may be found crowding together in the masses of London's huddled slums, and living the widely scattered individualistic life of the African desert. And as human criminals are found far from the haunts of men and in the city street, so the micro-organisms of disease may be found wherever man may spread infection. Yet disease caused by dangerous organisms must always come chiefly from dense micro-organic growths and heavily infected liquids.

Natural ice offers no very favorable opportunity for the continued life of even crowded bacterial communities. In another chapter I have spoken of three things favorable to bacterial existence, — warmth, nourishment, and darkness. Not one of these is present in pond, river, or pool when ice is forming. Light streams through the glasslike coating into the depths beneath. Bitter cold tends to shrivel and destroy plant-life. Nourishment is scant in winter waters. The environment in which these tiny bits of animate creation must carry on their struggle for existence seems forbidding in the extreme. Their life must be difficult enough in the cold liquid. How much more difficult it would seem to be when the fragile plants freeze into hard unyielding ice whose expansive force rends iron shells apart and splits the granite rock. No tale of life in Arctic snows could be more fascinating than the story of that microscopic struggle for survival in the bitter chill, observing that struggle simply from the standpoint of the ordinary observer. But its relation has an interest far more immediately personal than this, and one which concerns directly our immediate question. “Is city ice safe for use? If not, what can be done toward its

betterment?" We have already answered some portion of that question in our discussion of ice-formation. The rest of the answer must depend upon the scientific labors of the handful of men who have attacked this problem from its bacteriological standpoint.

In this day of hurrying clamor for reform, when journals leap into the arena thirsting for the blood of modern dragons of corruption one evening, and forget the next morning that such strange monsters ever existed; when every conceivable form of legislative regulation is gravely and soberly proposed; it is well to consider what touchstone may be found to give us some foundation for our beliefs, to enable us to act wisely and justly; for wisdom and justice are sometimes difficult to obtain even by legislative decree. It is fortunate that, in our work for the health of the city, we may settle many disputed points once for all by an appeal to the laws of nature as they are demonstrated in the laboratory. Any discussion for or against present-day ice conditions, for example, should rest either upon the records of past researches or the undertaking of new. The results of careful research should form the basis for the formulation of

laws or regulations intended for the betterment of conditions. We cannot afford the time to-day for discussion not based upon experimentation.

An advertising scheme, widely heralded in recent time, portrays the manner in which much of the experimentation on ice has been carried on. Some ingenious press-agent, desiring to show the indifference of his particular watches to heat and cold, froze timepieces in blocks of artificial ice. The result of his efforts is evident to any passer-by who notices an eager group pressing their noses against the jeweler's window and watching hour-hand and minute-hand moving over the white dials quite without regard to their unaccustomed frozen environment. The watch-manufacturer freezes watches in blocks of ice. The bacteriologists have frozen the bacteria which inhabit water in tubes of ice, or, reproducing nature in the laboratory, have frozen purposely-infected waters from the top downward.

Less than forty years reach between the two extremes of the quest. The beginning of the work was marked by the publications of two men: of Dr. Nichols, who reported the first recognized ice-epidemic, and of Burdon-

Sanderson, who discovered that melted ice or snow contained living micro-organic growths. The end may be said to have been reached in the comparatively recent work of Park of New York, of Hill of the Boston Board of Health, and of Sedgwick and Winslow. From first to last, nearly a hundred students have published papers on the kindred subjects of the epidemiology of ice and the life of the bacteria at low temperatures. Cycle by cycle, those individual researches fall into a series of groups.

The early work of Burdon-Sanderson, of Cohn, of Leidy, of Pohl, and of Heyroth, like that of several other pioneers, had a single aim, to determine whether or not bacteria could exist in naturally frozen water. In every case, these investigators inoculated sterile media (nourishing liquids or solids which were wholly free from micro-organic life) with natural snow and ice, and then observed the subsequent growth of bacteria. Pohl studied ice from the Neva. Heyroth investigated the supply of Berlin. The Massachusetts State Board of Health in 1889 analyzed two hundred and thirty-eight samples of natural ice; and the supplies of London, of Paris, of Vienna, and of other cities received attention. Bacteria

were found in every case. Scofone, on a scientific expedition to Monte Rosa, even found small quantities of bacteria at heights more than seven thousand feet above the surface of the sea. This preliminary cycle of investigation developed the first part of the general thesis. It proved that naturally frozen water could contain living micro-organisms. It did not test results by the essential touchstone of quantitative methods. Knowledge of the number of bacteria before and after freezing is the only thing which will give definite answers regarding the persistence of germ-life or the resulting danger from these forms. This information could not be obtained by any single counting of bacteria. Only by many countings of the number present before freezing, and of the numbers left after various periods of time spent in the frozen state, could really valuable and decisive results be obtained.

The group of experimenters who took up the work in what might be termed the second cycle did not obtain this necessary numerical knowledge, but, despite this, were able to carry the investigation some distance forward. Instead of working with natural snow and ice, they froze solutions filled with bacteria,

and submitted them, not only to freezing temperatures, but to degrees of cold far below that of ice. Von Frisch, Pictet and Young, D'Arsonval, Charrin, Ravenel, Janowsky, and others studied the problem by exposing cultures of bacteria to temperatures ranging from 10° to 400° Fahrenheit below the freezing-point of water. All proved that bacterial life could exist even when seemingly hardier organisms perished, but each secured his results by the use of bacteria living in rich and nourishing media, a condition vastly different from the normal life of micro-organisms imbedded in ice. This fact, that bacteria lived in severe cold when supplied with ample nourishment, told only part of the story. Not only that, but the results of the second cycle of investigation, from which came a more or less general belief that frozen water did nothing to free itself from impurities, were incomplete and unsatisfactory for another vital reason. Strangely enough, this body of investigators had not yet reached the point of testing their results by quantitative numerical work: they still relied on qualitative tests.

Few things are more essential to the city than for its citizens to acquire some measure

of the modern scientist's reliance upon quantitative methods ; for despite the fact that in the differentiation between qualitative and quantitative we find a distinction old as the race itself, the average person pays little attention to quantitative results. Qualitative experiment is like aboriginal cooking, where quantities are unconsidered and the prepared food may vary through all degrees from bad to good. Quantitative experiment, with its possibilities of good results, has existed since that moment in the dawn of civilization when primeval woman first measured out her breadstuffs in a stone cup, and, trying different quantities, finally reached a definite amount which would serve her as a standard for her later production of good bread. Progress has always passed through *what happens to how much happens* ; from gathering crops at random to the computation of bushels per acre ; from the stifling heat and foul air of the old school-rooms to the proper number of cubic feet of fresh air per individual in the new ; from the general fact that cold will not kill entire bacterial populations to the exact numerical part which the cold of ice plays in limiting or partially cutting off the numbers of the micro-organisms present.

Such a change from qualitative to quantitative methods characterizes the third cycle of the researches on ice. Frankland, Pengra, Fränkel, and others had made isolated efforts at obtaining numerical results; but it was left to Dr. Prudden of New York to consider the problem for the first time by the use of careful quantitative methods, used with relation to certain specific micro-organisms of disease. Using an analogy with the study of men, we may say that Prudden's work marked the point where this research passed from general anthropology to specific criminology. For the first time the purpose of an investigator bore directly upon those germs which are responsible for water-borne disease. Using definite counted numbers of bacteria, and observing their endurance, their period of life, under frozen conditions, Prudden determined that many bacteria were killed by freezing, that different species are very differently affected by the cold, that alternate freezing and thawing are likely to be fatal, and that the number killed increases as the length of time in a frozen condition is prolonged.

Prudden's results, excellent as they were, left much to be desired. There were various

possibilities of error in 1887, when this work was done. Methods of bacteriological work had not reached the degree of excellence afterwards obtained, and the general knowledge of sanitary science had increased enormously during the twelve years which elapsed before Sedgwick and Winslow began their research in the biological laboratories of the Massachusetts Institute of Technology with regard to the "effect of freezing and other low temperatures upon the viability [the capacity of living] of the bacillus of typhoid fever, with considerations regarding ice as a vehicle of infectious disease."

In this investigation, for the first time, bacteriological research on ice was concentrated in such a way as to apply directly to the immediate service of man. Although Prudden had used pathogenic germs (the micro-organisms which cause disease), his labors had been confined largely to comparisons of various bacilli. Now, as a student of the criminal classes might specialize on a single branch of his subject, such as forgery, so the present consideration narrowed down to the one chief water-borne disease of the temperate zone, typhoid fever.

Three striking results appeared as the experiment progressed. First, as regards the per cent of micro-organisms which perished as the time of endurance of cold continued. Fifty per cent of the total number died in half an hour. Less than one per cent of the total number survived after fourteen days. Beyond that time-limit, a slow, steady reduction continued until either every micro-organism perished, or the numbers of the bacilli were diminished to an apparently irreducible minimum.

In duration of time, then, — in the storage that ice receives in the ice-house, to put it more practically, — is to be found one of the greatest factors in the elimination of what might be called the internal organic life of ice. We have already considered how crystallization and gravity work towards that end. We shall see in a moment how this research brought the conclusions on that subject to a laboratory basis. Here we have figures which relate directly to the storage factor, to the length of time ice must be stored before its dangerous bacteria die. Practically all the natural ice which comes to the city is stored for weeks or months before use. Time is a great factor in stamping out the micro-organisms of disease.

Able as many are to endure low temperatures for brief spaces of time, the greater part of them die under long exposure to the cold.

A second fact appeared upon investigation. Prudden had already noted that the number of bacteria killed by freezing varied with the species, that such tiny organisms as the ironically named *Bacillus prodigiosus* lived their life in their icy world in a different way from the *Bacillus typhi*. Now came the conclusion, not only that different species of bacteria were differently affected by the same conditions of cold, but also that within the limits of a single species existed distinct races marked by strongly variant powers of resistance. Four separate races — which the experimenters named A, B, C, D — were considered. All were presumably of the same typhoid type. Striking differences, however, appeared between them. Race C succumbed to the cold far more readily than Race B. Races A and D were neither as weak as Race C, nor as strong as B. Similar variations showed in the growth of each individual race; and the conclusion was finally reached that in different races of a single bacterial species the number killed varies with the race. As in the case of man, we can observe the

varied resistance which Northerner and Southerner offer against the invasion of cold and heat; as we see the Negro living and flourishing in climates which destroy the white man; so we may see that one alien bacterial stock dies out in an unaccustomed clime where another persists.

Important as are the conclusions arrived at concerning the purifying effect of storage, another part of the research bears peculiarly closely upon the public health — that which regards the “effects of sedimentation and crystallization during the freezing of typhoid-fever bacilli in water.” The work of every early investigator was marked by a common error, — the conditions under which the bacteria were frozen were not the same as those which obtained in the formation of natural ice. The culture-tubes were frozen in a solid block, a way in which natural ice never freezes. In this case an attempt was made to copy the work of nature rather than to follow that of previous experimenters along the same line. Heretofore, the purification of the free ice of the lake solidifying under the winter sky had received but little attention from the men who observed bacterial life in the ice-tubes of the

laboratory. Make one exception, — the presence in natural water of multitudes of hostile infusoria, tiniest of scavengers, who may devour forests of microscopic plants which gravity is drawing towards the bottom, — and all the natural circumstances surrounding ice-formation were reproduced in this research.

This portion of the investigation offers an excellent demonstration of the hypothesis that, if natural phenomena are to be subjected to laboratory examination, natural conditions must be duplicated. Certainly, no reference to the necessity for exact duplication of nature's processes appears in the fairly extensive literature collected for this chapter up to the time that the Sedgwick and Winslow research is reached. The way in which the inherent difficulties of this problem were overcome was most ingenious. Placing about ten gallons of sterile water in a carefully jacketed wine cask, the experimenters inoculated the liquid with typhoid bacilli and exposed the cask to temperatures below the freezing-point. The jacketing of the sides and bottom of the cask produced a condition similar to that of a natural pond. Cold could enter only at the top. The ice could grow in but one direction, downward. Natural condi-

tions were reproduced, and it was found that the ice contained about one tenth as many bacteria as inhabited the water below. The tendency of natural ice to purify itself by the aid of gravity and crystallization had been demonstrated under laboratory conditions.

Three conclusions may be drawn from this research. First, one race of a certain pathogenic germ may persist where another dies. Second, whatever the persistence of any race, exposure to long-continued cold, such as takes place in the natural storage of ice, cuts the numbers of the bacteria to a very low quantity. Third, crystallization reduces the numbers in nearly as great a proportion as storage. Since crystallization and gravity exclude 90% of the organisms present in any germ-body of water, cold and storage combined exclude almost 99%. When these factors are added together, as they ordinarily are, we may reasonably conclude that ice so formed is safe, provided we hold to our original criticism of the topmost layer. There the number of micro-organisms may be so great as to defy the destructive agencies. The common belief that disease-germs may live for months in ordinary clear natural ice seems unfounded, and the empha-

sis is placed on a new point, the possibility of the contamination of ice through human carriers and unclean resting-places.

Scarcely another article of human consumption receives so much direct handling just before its use as does this food. Milk and water, tea and coffee, are poured. Bread, meat, and butter are cut. Bread, probably handled more than any other food on the list, has a hard crust, which offers a rather unfavorable lodging-place for germ-life. Ice, on the contrary, washes the hands of every person who handles it, and affords an ever-ready liquid medium for the immediate absorption of the hosts of bacteria which hands may carry. The carelessness of the handlers of ice, their utter disregard of the resting-places where it may receive infection, may be due partly to their lack of realization that ice is a food, as real a food as meat. Whatever the cause, few substances which pass through the digestive processes of man receive such treatment. Its surface contaminated by the passage of men and horses in the cutting, its sides and base fouled by muddied platforms and dirty straw, covered with the filth of black ice-cars and dust-swept freight stations, your cake of ice

commonly receives its only cleaning just before it enters the ice-chest. So far as the ice-man is concerned, this is generally a hasty brush with a time-worn whisk-broom, well filled with the dust of the street and blackened with constant use. According to the personal testimony of various ice-men, not even the precaution of a momentary washing beneath the faucet is ordinarily taken. Add to this lack of cleanly control the immediate contamination of the server's hand who prepares the ice just before meal-time, and you have excellent opportunity for infection. And this infection, contrary to the conditions which prevail with water and milk, will be normally a producer of isolated disease rather than of epidemics. The proper management of house-conditions rests upon the consumer, but there is much that can be done before ice reaches the house.

Few of the city's necessities possess such possibilities of regulation as the one considered here. Water, springing from a thousand rills, is the bearer in solution and suspension of a great portion of the matter which it meets upon its travels. Only by extraordinary precautions, by complete control of miles of watershed, or by carefully constructed filters, can

it be cleansed. From the moment of its inception to that of its actual use, water must be kept pure and free. Milk, produced in hundreds of isolated dairy farms, small and large, enters the city in a flood, daily renewed, and requiring daily, almost hourly, inspection. Vegetables and other provisions come in by every thoroughfare.

Sharply contrasted with these are the conditions of the city's ice. Harvested in great bulk, since small ponds no longer produce paying quantities, a glance at any large-scale topographical map will show the sources of supply. Inspection of sources in consequence becomes a matter of long jumps from point to point. Entering the city through centralized freight stations, ice from a distance could invariably be discharged (as it commonly is) at a few distributing points, where single inspectors at each terminal could determine its condition. In the cases where ice comes in by wagon, it must originate in bodies of water close at hand. These are few at best and easy of centralized control. Concealment of unfortunate conditions in a pond open to the eye of every wayfarer is far more difficult than similar concealment inside four walls, just as immu-

nity from the consequences of assault and robbery is a much greater problem in the public square than it is in the back alley. The ice-dealer who attempted to overflow his ice, or to join thin cakes in violation of law, would have no easy task to do it unconvicted. Even if regulation did not extend to the control of the sources, an enforced law requiring the planing off of the topmost layer would do much. Artificial ice-control is made simple because of the fact that the manufacturer must produce his product in accessible central locations, and each city will support but few plants of this type.

Municipal or state control of the ice business is more than practical, then. It is inexpensive. The comparatively small number of individual and corporate ice-dealers in each city makes the issuance of licenses a very much less complicated matter than the present issuances of permits to peddlers, to milk-men, and to other purveyors of the city's foods. Inspection of most food-supplies must occur almost hourly. Inspection of ice need be little more than semi-annual. Visual examination of the pond, the ice-house, and the methods of transportation, bacteriological examination

of samples at harvesting and shipping times, regulations against the use of snow and over-flowed ice, or proper provision for planing, control of artificial ice-factories in respect both to water-supply and to construction,—all these matters could be governed with a minimum of cost as compared with the possible results obtained.

That great example of the individualistic life, our old friend Robinson Crusoe, before he took up a community existence with Friday, drew up, as you will remember, two parallel columns of bad and good. The critic of the city's health, striving to adjust a balance, may set down the results of his reasoning somewhat as follows:—

All the bacteria of disease are not killed, even by temperatures far below the freezing-point of water.

But when the bacteria have to live for long periods in ice, as they commonly do in ice-house storage, the greater part of them perish.

Snow-ice and upper ice may be filled with surface impurities. It is the top layer which needs cleansing.

This layer can be planed off.

There is grave danger of contamination from handling.

That is true and hard to combat. But the remedy for it lies in the awakening of individual interest.

There is pressing need for proper general control of both the natural and the artificial ice-supply.

But there are unusual possibilities of complete control in the dawning recognition of the fact that the citizen must guard himself and his family by the advice and service of trained experts. Many as are the ways in which the state can protect her children, her greatest reliance must always be the education of the individual citizen, the formation of standards of life, and of approachable ideals.

VII

SEWER-GAS AND PLUMBING

THE chapter which follows is frankly and unreservedly a tale of research. It is an attempt to tell the city householder what is actually known about sewer-gas, and to explain some of the studies made in recent years on house-drainage and plumbing with regard to their bearing on the public health. It gives the story of a notable public action on the part of a craft. It includes a brief discussion of actual plumbing conditions, and of the regulations made to avoid the dangers which have been believed to come from wastes which leave our homes. Since the plumbing of our houses is the barrier between us and substances which might rise from the sewer's stream, it is a matter of immediate importance to every city-dweller to know the relation between sewer-air, house-drains, and the health of the inmates of each home.

Few of the sanitary theories of the city worker are more firmly fixed than his belief

in the dread effect of sewer-gas. He may have no hesitation in drinking water whose source offers every possibility of pollution from typhoid-germs, and may fear no danger in the milk which feeds his child. He is, however, generally strong on drains. What is more, there are probably few sanitary matters on which there seems to be more personal evidence. So many people can refer you to some house where there have been cases of diphtheria, pneumonia, dysentery, or typhoid, and in which broken drains or leaky drain-pipes have been discovered. Trace those cases down, compare them with the total amount of reported sickness from these specific diseases, and you begin to become skeptical. No epidemic of disease has been reported where reliable statistical evidence exists of causation by sewer-gas. There are undoubtedly well-authenticated reports of sporadic illness where sewer difficulties have existed. We can hardly make generalizations from these reports, however, for the simple reason that there are leaking drains on every hand without disease. Epidemiology, however, is filled with reports of disease whose causation has been definitely traced to water or to milk. Is it not possible

that the danger from this special source has been exaggerated, and that in attributing much trouble to this cause we have been led to neglect the greater dangers of poor water, poor food, overcrowding, and bad air? There are plenty of real evils in the city. We have no time to fight with chimæras.

Two theories of the harmfulness of sewer-gas hold the stage to-day. The first and less common is not yet definitely proved or disproved. It concerns the possibility that sewer-gas may predispose to disease, may create a state of lowered vitality in the human frame in which that tendency to immunity from disease which the healthy body holds is weakened. Of the relation which that theory bears to the public health we shall speak later. The second is the common theory that the germs of disease rise directly from the sewer. This chapter tells of the researches which have proven this popular belief to be untenable.

Before we turn to the story of the search for the truth or falsity of the charges made against sewer-gas, let us pause briefly to consider some of the facts on which that search was forced to depend. According to the Century Dictionary, sewer-gas is "the contami-

nated air of sewers." Assume that to be the common definition, and expand it. The air of a sewer, in its chemical composition, can be little different from the air of a street. The chemical elements and compounds which compose the great body of the atmosphere are the same in either case. If sewer-air is contaminated, that contamination can arise only from one of two causes, — either from the addition of poisonous gases which are produced by the decomposition of the organic wastes which sewage contains, or from the rise into it of dangerous micro-organisms present in the liquid which flows through the sewer-pipes.

The amount of poisonous gases likely to be evolved from sewage is small. Sewage is made up from the washings from sinks, from water-closets, from a hundred processes involving the use of water, from rain and melted snow. It runs to its ultimate destination in a greatly diluted flood, which seldom contains more than one part in one thousand of organic matter. That amount could furnish but little gas under any circumstances. Add the fact that the evolution of gases is dependent upon decomposition and that sewage is rapidly hurried on to its place of disposal: it is evident

that it can seldom advance to the point where there is any material amount of decomposition. In this connection it is especially worthy of note that, according to Richards and Woodman, ill-smelling gases are given off only when sewage is about eighteen hours old. It is true that sewage, standing in the septic tank, may produce much gas. Such evolution of gases occurs, however, only under anaërobic conditions, conditions where air is excluded. It occurs when comparatively concentrated sewage is stored for shorter or longer periods of time. To-day sewage is swiftly removed from the well-sewered city, and the danger of large amounts of gases rising from the sewer, in which the liquids are carried to their point of final disposal, is slight indeed. The house-drain, the broken pipe from which sewage seeps into the soil, the ill-constructed waste-pipe, the cesspool where stagnant liquid stands, might provide more.

Rightly enough, the possibility of direct germ-infection from the sewer has attracted the most attention. We may learn from any analysis that there are great quantities of the germs which cause disease in the fresh liquid sewage of any city. It is a matter of very real

importance for us to know whether or not these micro-organisms are likely to fly upward, escape into the air above, and infect the household. Speculation on this point is wholly valueless. Once more we have one plain way before us — a quantitative and qualitative examination of sewer-air, to determine whether or not it is more dangerous than the every-day air that we breathe throughout the twenty-four hours of the day. Many people breathe the most dust-laden atmosphere without a thought of harm, who believe sewer-gas a deadly miasma. Here is a chance for a comparative study. Let an investigator take equal quantities of street-air and sewer-air and examine each sample, under the rigorous laws of the laboratory, to determine how many bacteria are present and what kind they are. If rightly carried on, that will tell the story, furnish the proof. If the air of the sewer is heavily laden with bacteria and contains the germs peculiar to sewage, while the air of the street does not contain these germs, the case against sewer-gas would seem well on its way to be proven. If, on the other hand, sewer-air contains practically no more bacteria than street-air holds; if it is free from the danger-

ous organisms found in liquid sewage, it would look as if we had been falsely alarmed concerning the possibility of direct infection from this source.

As has been mentioned before, it is not enough to investigate natural phenomena under one set of conditions or with limited amounts. Truth is always difficult to attain. Only by repeated investigations, made under the closest possible approximation to natural conditions, can the truth be found in the laboratory. The air of the sewer may be inert, stagnant. It may vary in velocity from a gentle breeze to a rushing wind. The swifter the wind, the greater the possibility of its raising germs from the surface of the liquid below. Sewage normally flows in a quiet, steady stream. But water falling into it goes down in a cascading spray filled with bubbles of air. Gases, generated in its depths, may rise to its surface. Both the quiet liquid and the bursting bubble should be investigated. The research to determine whether or not dangerous germ-enemies of man exist in sewer-air should be carried on under conditions which actually occur.

There are some peculiarities of certain mem-

bers of the bacterial family which should be mentioned here. Two of the bacteria most closely connected with the problem before us are the *Bacillus coli* and the *Bacillus typhosus*. Constantly found in the intestines of man and of many of the higher animals, the colon bacillus is especially characteristic of sewage, where it is found in enormous quantities; while the typhoid bacillus is the micro-organism which, beyond all others, causes water-borne disease in temperate climes. These two bacteria are closely related. Their prevailing form is that of a plump, straight rod, with rounded ends, which is approximately one twenty-five-thousandth of an inch in length. Similar as they are, they can be clearly distinguished by bacteriological methods. Both of these tiny germs have perceptible weight, and swiftly settle out of the air. Following the general rule of the bacteria, they flourish in dirt, darkness, and moisture, all of which conditions are found in sewage. There is no condition known in which they tend of themselves to leave any quiet liquid media for the air. As we shall see, these characteristics play their part in the story which follows.

The three countries most interested in san-

itary reform, Germany, England, and America, each offered their share of investigators, to the end that more light might be shed upon this question of direct infection from the germs of the sewer. The experimental results reached in every country were similar, and have convinced the great body of experts in Germany and the United States. They have not been sufficient to overcome the conservatism of some British sanitarians, who have been more affected by the reports of local authorities, who have attributed typhoid and other epidemics to poor drains, than they have been by the carefully controlled work of the laboratory. France and Italy, in the work of Miquel and D'Alessi, have furnished two of the most noteworthy researches of the series. Mention of the first of these will be made in the immediately following paragraphs. Reference to the second must be postponed till the consideration of the second half of our topic — predisposition.

Britain's contribution to the subject may be said to commence with the work of Sir Edward Frankland, who, like Pumpelly in America, made a careful investigation of the bacterial life existent in air above quiet liquid

sewage, and in air above sewage from which bubbles of gas, generated by the decomposing organic matter, were rising. Both Frankland and Pumpelly decided that, under ordinary circumstances, germs could be thrown off only by the bursting of bubbles, that they did not rise from the quiet liquid. Carnally and Haldane, in a long and careful study of English and Scottish cities, found in practically every street a greater bacterial population per given quantity of air than was found in the sewers beneath the street. The kinds of bacteria occurring in street and sewer were the same, and wherever, for any reason, the number of the micro-organisms increased in the street, they increased proportionally in the sewer. Laws and Andrewes, in a similar investigation, carried the matter yet further. They determined that moulds and micro-cocci, both especially characteristic forms of street-air, were most abundant in sewer-air. Even more important in some ways was the discovery of these investigators that the *Bacillus coli*, the most typical bacterial form of sewage, was not found in any sample investigated.

The German results include numerous investigations, from those of Nägeli, who con-

cluded in 1877 that "infectious materials, in general, pass into the air only after drying, and then in the form of dust," through the work of Uffelmann, Flugge, Petri, and Ficker. Discussing the whole matter in 1895, Kirchner and Lindley, in a paper read before the German Society of Public Health, came to the following conclusions: —

"1. The assumption of the spread of epidemic diseases, such as Typhoid, Cholera, and Diphtheria, by sewer-gas does not harmonize with our present knowledge of the nature of the causative agents of these diseases.

"2. On the other hand, the gaseous products of decomposition arising in sewers and house-drains may be harmful, indirectly if not directly, to those exposed to them for a considerable time; they may produce nausea and may lower the general tone of the body, including its resistance against disease."

One of the most interesting investigations of the whole series is the comparative study made every year for sixteen years by Miquel, who annually, for that whole period, counted comparative numbers of the bacteria found under similar conditions in Paris streets, in the French countryside at Montsouris, and in

Paris sewers. Some amazing results as regards numbers were secured. If we average four years of the series, we find approximately one bacterium in country air to fourteen in the sewers and thirty in the street, the exact results being 1 to 13.817 to 29.976. According to Miquel, in these years there were about half as many micro-organisms in the sewer as in the street.

In America, besides Pumpelly already mentioned, Abbott, Hazen and Ruttan, Whipple and Harrington, came to similar conclusions,—that the danger of infection from germs rising from the sewer was practically negligible, and that bacteria rose only when they reached the sewer in spray, or were thrown from it on bursting bubbles of gas.

In 1905 affairs rested on the basis of the experiments just described. German and American sanitary authorities in general did not believe that direct infection from the germs of the sewer was at all probable. One section of the body of British sanitarians thought differently. A large proportion, if not a majority, of the general public were convinced that typhoid, diphtheria, and other similar diseases rose directly from the sewer when there was

any drain trouble in the house. Then, in 1905, occurred an event, which seems to the writer one of the most notable recorded in this book, — the determination of a craft to take up officially a scientific investigation, through the employment of trained investigators, who were to conduct a research in one portion of their field of labor. The National Association of Master Plumbers of the United States, acting upon the suggestions offered by their Sanitary Committee, authorized that committee to make plans for an investigation, to determine, in the words of the report, “how much sewer-gas was to blame for the carriage of disease, and if so, to what extent.”

It is a remarkable tribute to the gradually spreading belief in the touchstone of the laboratory that this committee, finding no place in the world where investigation of the questions which they desired to have settled was being carried on, started upon a research of their own. Most corporations have already learned that a chemist may save them thousands of dollars. Many business interests have come to recognize that research which involves utilization of by-products, or produces methods for shortening processes, means greater

profits. It is certainly rare, if not unique, to find a national association of a craft commencing such an undertaking for the public health, spending money for an enterprise which did not immediately affect the pocket-books of the members.

There was, fortunately, one place where problems of sewage-disposal had been especially considered for some years. Since 1903 the Massachusetts Institute of Technology has maintained a Sanitary-Research Laboratory and Sewage-Experiment Station, designed, in the words of the catalogue, for "the investigation of problems relating particularly to the purification of the sewage of large cities, for the demonstration of sanitary methods and appliances, and ultimately for the advancement of popular education in public-health subjects." The Sanitary Committee of the Master Plumbers, consisting of David Craig, chairman, and Messrs. Balme, Decker, Morgan, and Highlands, arranged with the Institute of Technology to erect needed experimental apparatus in the laboratory of the sewer-station, and intrusted the work to Professor C-E. A. Winslow of the faculty.

The investigations which preceded the one

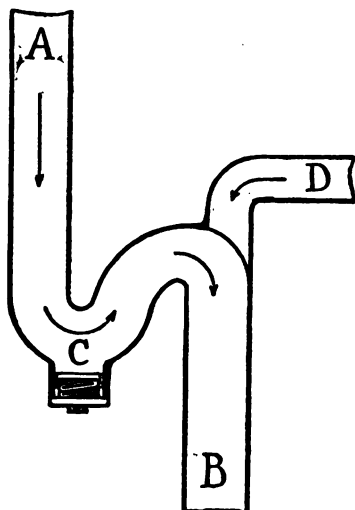
now under consideration had been concerned chiefly with sewer-air proper, that is, with the air in sewer-pipes, not with the air of house-drains. It had been reasonably established that sewer-air was freer from germ-life than the air of the street. It had not been proven that, assuming the ordinary conditions of the discharge of water from a water-closet or a sink in a house, germs from a broken drain, a cesspool, an unsealed trap, or a badly placed vent might not make their way into the air of rooms. It was just this question of the possibility of danger from house-plumbing that this research undertook to solve.

Plumbing is *terra incognita* to so many of us that a word about the means employed to remove wastes from the household may not be amiss. In his "Municipal Engineering and Sanitation," Baker writes that the essentials of sanitary plumbing are simplicity, durability, accessibility, and air-tightness. To these requirements, Harrington, in his "Practical Hygiene," added thorough ventilation and plentiful water-supply. Open plumbing, by its simplification of repair and construction, has done much to accomplish those ideals. The necessity for sound materials has brought

about a general use of cast iron, instead of lead, for soil-pipes, a notable change for the better, as iron is lighter, stiffer, and more durable; its stiffness prevents the sagging and pocketing possible with lead. The soil-pipe furnishes the means of exit to the wastes. With it, as with all the removal apparatus, a first essential is such construction that there shall be no possibility of leakage for solid, liquid, or gas. The soil-pipe, however, does nothing more than provide a road for removal. Protection against the return of sewage or the influx of sewer-gases is centred in the trap and the vent.

A trap is a device for providing a water-seal to the plumbing of a house, by causing some of the passing liquid to lodge in a pocket or depression. It may be manufactured in many forms and shapes, but the simplest one of all is the running trap shaped like a U. The wastes enter this trap at A and leave at B. No matter how much water passes through, C should be left filled with liquid. This liquid seal prevents the passage of air from the sewer to the house. A vent or air-pipe, D,—the round iron pipe which you may see rising through the roof of your neighbor's house, leading to

the outer air,—is placed on the outflowing side of the trap to provide ventilation for any gases which, accumulating in the pipes,



might force sewage back into the bowl. It has been believed that the vent does away with any possible siphoning or emptying of traps because of the sudden rush of water through them.

In actual practice there are three possibilities of sewer-air or sewer-gases rising into a house through a trap. The level of water in the **U** of the pipe may fall so low as to leave the

trap only partially sealed. The liquid, through some flaw, may disappear altogether. Gases generated on the sewer side may exert sufficient pressure on the liquid in the water-seal to force their way through to the soil-pipe. It is possible, moreover, though hardly probable, that germs might rise from the wetted interior surface of a soil-pipe. We have already seen that bacteria have a perceptible weight, and tend to settle rather than to rise. Even with an open trap, the only possibility of getting them into the house would be when they were borne on a strong air-current.

We have briefly reviewed the plumbing conditions which were to be investigated. Now, strangely enough, as we turn back to research, we find a comparative quiescence of some years changing to an active interest in the matter of sewer-air. There began at this time a series of rival investigations, attaining different ends and forming a striking story of a struggle to wrest truth from the laboratory. A first research carried on by Professor Winslow was met by a research which reached almost diametrically opposite results, carried on by Major W. H. Horrocks of the British Army. The Horrocks conclusions were startling in

the extreme, for they seemed to show that the greater part of the results already accomplished were false, and that disease-germs could rise from the sewer. A second research conducted by Professor Winslow followed the work of Horrocks step by step, showed the fallacies of the conclusions which he reached, and proved that we may be freed from one of the fears of sewer-gas which has long loomed over us. How that laboratory struggle was carried on, the next division of this chapter shows.

The necessity for reproducing actual conditions in researches concerning the public health has been mentioned more than once in this book. It is interesting to note how closely that rule was followed in the investigation authorized by the Master Plumbers. Stock plumbing materials, of the same sort that would be put into your house, were used. A four-inch cast-iron soil-pipe, fifteen feet long, was connected at the bottom with an ordinary running trap. Currents of air, varying in velocity from four hundred and ninety feet to seven hundred and ninety feet a minute, were driven through trap and pipe. No normal conditions would ever see an air-current of even five hundred feet a minute passing through a trap. The air in the soil-

pipe was examined at different levels, with the trap sealed with sewage, partially sealed, and unsealed, and with the pipe dried and wetted. Under no circumstances were any large number of bacteria found in the air. Only when the air-current was rushing through at its higher velocities were any bacteria dislodged at all. The conclusions of Professor Winslow follow:—

“On the whole, it appears that germs are carried into the air of a house-drainage system from its traps or wetted surfaces only by suction corresponding to an air-current of six hundred feet per minute. It is scarcely conceivable that such a force could be exerted under any practical conditions. The friction in a four-inch pipe is so great that a fairly hot fire inside it could hardly produce such a draft as this, and wind, blowing across the top of such a pipe and directly into its fresh-air inlet at the bottom, could cause so strong an up-current only under exceptional conditions. It seems, therefore, that the carriage of disease-germs from the air of a house-drainage system is an improbable contingency.”

In the same year (1907) that the investigation just mentioned was completed, Major W.

H. Horrocks of the Royal Medical Corps reported to the Royal Society the results of a series of experiments made at the Fortress of Gibraltar, especially at the Military Hospital. How widely the conclusions reached by this investigator diverged from those just related, the following paragraph will show.

The results obtained by Major Horrocks, followed by the confirming report of Dr. Andrewes, startled the world of sanitarians. Making a frothing soap-solution strongly infected with a test bacterium, the *Bacillus prodigiosus*, Horrocks investigated the air in drains, in pipes, and in various parts of sewers, by placing open dishes, containing sterile nutrients, at points above the infected solution. The plates one and all showed the characteristic red colonies of *Bacillus prodigiosus*. Experiments made with the typhoid bacillus under similar conditions showed cultures of this organism. The investigator concluded that "Specific bacteria present in sewage may be ejected into the air of ventilation-pipes, inspection-chambers, drains, and sewers, by (a) the bursting of bubbles at the surface of the sewage, (b) the separation of dried particles from the walls of pipes, chambers, and sewers, and

probably (c) the ejection of minute droplets from flowing sewage."

Results so contrary to the previous work accomplished naturally provoked much criticism. On their publication the Sanitary Committee of the Master Plumbers' Association took up the problem anew, and commissioned Professor Winslow to carry on a second series of experiments to check the results obtained by Horrocks, and to carry them further if possible. This was especially necessary, as the Horrocks experiments had been made in a somewhat different fashion from any hitherto attempted. Soapy water was used. The method of leaving plates containing nutrients freely exposed to the air for considerable periods of time, commonly for twenty-four hours, left great possibilities of contamination. Such contamination might proceed, not only from a worker lowering the plates to place, but also from the more probable cause of infection by dust and flies. Most of the Horrocks tests were qualitative not quantitative, as the plates examined were simply exposed for various periods of time to unmeasured volumes of air.

The isolated fact that harmful bacteria are found in any place is not necessarily a sign of

danger. They are so plentiful that we can scarcely escape them, and their growth is so rapid as to be almost beyond our comprehension. These micro-organisms grow by division, and some of the species grow so rapidly as to divide twice every hour. One at the beginning of an hour, therefore, means four at the end, if all survive. The rapidity of this type of multiplication is extraordinary. In a day, if nothing stopped the growth, H. W. Conn has figured that one bacterium would have 16,500,000 offspring, so to speak. Two days would produce 281,500,000,000, which would form a solid pint of bacteria, weighing about a pound. Three days, still assuming that nothing stepped in the way of the growth, would produce forty-seven thousand billions, which would weigh about sixteen million pounds. These figures are of course wholly theoretical, for the simple reason that something always does step in the way. Before the descendants of the bacteria reached even to the millions, lack of food, overcrowding, and the accumulation of their own life-processes would stop their further growth. But the essential point remains,—that bacteria multiply with a swiftness almost beyond our ken. A thimbleful of milk may contain hun-

dreds of thousands of these organisms. Its content may easily reach to the millions. The milk is unusually pure if it contains less than ten thousand in this slight volume. A quart of infected milk may easily contain billions of these tiny bodies.

It must be evident from the preceding paragraph that the mere presence of bacterial life is not a sign of danger. If it were, we should never be free from peril. Major Horrocks's results showed the presence of some indicator-germs (germs intentionally used to test conditions) like *Bacillus Coli* in sewer-air. The essential problem which he left unsolved and which the next research answered is this, — Does the presence of comparatively few indicator-germs mean any real probability of getting any disease-germs at all? New York City water, a surface-water of good quality, will almost always contain one hundred bacteria of the sewage type to a quart of water. Such a bacterial content indicates a slight degree of pollution which would be better done away with, yet New York water is drunk without serious harm by hundreds of thousands of city-dwellers. A quart of water is a small amount for use during a day. If we breathe in no

more harmful germs than that amount contains, we shall probably suffer no injury from specific infection caused by the germs of sewer-gas.

The second part of Winslow's work on this subject was devoted to a careful imitation of the Horrocks methods and a still more extended examination of the air in plumbing systems actually in use in residences, hospitals, offices, and hotels. The report of the Sanitary Committee of the Master Plumbers for 1909 gives the full story of this search. It contains the answer to our original comparison of equal quantities of street-air and sewer-air. It involves three of the most interesting applications of the possibility of joining actual conditions to laboratory methods that have been recorded.

Entering the Boston sewer in a boat-chamber, the investigators placed dishes containing sterile nutrients beside the eddying stream of sewage, and on various steps leading to the street. The colon bacillus characteristic of animal wastes was found on every plate, *but* the numbers of these bacilli were *smallest* nearest the sewer, *greatest* nearest the street, and the increase from sewer to street was constant.

Remember the point made earlier, — that these organisms, tiny as they are, have a perceptible weight and settle swiftly, — and you will see that these results indicate one thing, — that the bacteria found in sewer-air come chiefly from street dust infected by such agencies as manure, not from the sewer.

A soapy solution, like that used in the Horrocks experiments, was next tried. Qualitatively, without reference to numbers, it appeared that bacteria could be drawn into the air from heavily infected solutions. In eight careful investigations it was shown that but seven test bacteria (*Bacillus prodigiosus*) appeared in air above foaming liquids containing over fifteen billions of this specific organism. Dilution such as this can harm no one. Winslow carried the matter still further. Setting up an ordinary water-closet, and reproducing the natural splashing of water passing through it, he examined forty-four samples of air to see if infection could take place under these conditions. One case of contamination, and only one, occurred. One plate, and only one, was apparently infected by a single drop. Again quantitative methods showed that the possibility of disease from the germs of an ordinary

house-system were too slight to be considered. The investigation of nineteen plumbing systems in actual use showed the general air of house drainage-systems to be amazingly free from sewage organisms, far freer, in fact, than the air of the street or the common water-supply of many cities.

According to this investigation, therefore, a man in an ordinary room would have to breathe undiluted sewer-air for twenty-four hours on a stretch to take into the system as many sewage bacteria as a pint of New York water contains. Only at those points where sewage splashes into spray does the bacterial content increase above this ratio, and then only for a few moments. Suppose we sum the matter up with the closing sentence of Professor Winslow's report: "I believe, however, that my results, in the light of all previous evidence, warrant the conclusion that the chance of direct bacterial infection through the air of drains and sewers is so slight as to be practically negligible."

The results obtained by Horrocks failed in two respects. His use of heavily infected, foaming emulsions to represent sewage did not actually represent the conditions which exist in

a common house drain-pipe or in the sewer. His reliance on qualitative measures did not give sufficient information as to actual everyday conditions. Bacterial life is so widespread, so nearly omnipresent, that the mere presence of various organisms in air is not enough to condemn the air. There is a possibility of the presence of harmful micro-organisms, but it is slight. Were we to consider all such risks, we should live under a never-lifting cloud of fear. Man must take some chances, and in comparison with graver dangers we may consider the possibilities of harm from this source negligible.

In the preceding portion of this chapter I have considered the grounds on which sanitarians base their disbelief of the common theory of the carriage of infectious disease by germs in sewer-air. There remains, however, a second possibility which has received comparatively little consideration. One chance of deleterious action on the part of sewer-gas remains: the general predisposition to disease which may be caused by the constant inhalation of odors, or of such gases as ammonium sulphide, carbon monoxide, and hydrogen sulphide, all of which possess poisonous properties,

and all of which may be generated during the decomposition of organic matter. Records are in existence which tell of deaths caused by accumulation of heavy gases in cesspools and in dead ends of sewers. Such deaths were caused by suffocation or by direct gas poisoning. They are few in number, and the testimony of vital statistics shows that sewer-workers are unusually strong, with a high mean age at death and a low death-rate.

Vital resistance, the varying powers of different persons to resist disease, is no slight factor in sickness. It is entirely possible that the odors of sewer-gas, interfering with appetite and digestion, might weaken the general condition. There has been one, and, so far as the writer knows, only one investigation into the problem of predisposition to disease resulting from exposure to sewage. This was the research conducted some years ago by Dr. Alessi of the University of Rome. The results of that investigation indicated that animal life, when exposed to the effect of gases produced by decomposition in sewage, lost its power of resistance to certain specific germ-diseases. Notable as these results were, their lack of confirmation and their comparatively

limited extent enjoin caution before they can be accepted as wholly authoritative.

Roechling, the author of the important work "Sewer-Gas and its Influence on Health," believes that the action of sewer-gas may predispose the individual to the attacks of disease; and no small number, especially of British sanitarians, as has been said, agree with him. It is an interesting commentary on the other side of the question that, of six American books on the causation of disease, taken at random from the shelf, the indexes of one half show no reference to odors or to sewer-gas.

A quotation from Dr. William Budd, given in Sedgwick's "Sanitary Science and the Public Health," is so peculiarly pertinent to the matter in hand that a part of it will bear repetition here. "The need of some radical modification in the view commonly taken of the relation which subsists between typhoid fever and sewage was placed in a very striking light by the state of the public health in London during the hot months of 1858 and 1859, when the Thames stank so badly.

"Never before had nature laid down the data for the solution of a problem of this kind

in terms so large, or wrought them out to so decisive an issue.

“An extreme case, a gigantic scale in the phenomena, and perfect accuracy in the registration of the results—three of the best of all the guarantees against fallacy—were combined to make the induction sure. For the first time in the history of man, the sewage of nearly three million people had been brought to seethe and ferment under a burning sun, in one vast open cloaca lying in their midst.

“The result we all know. Stench so foul, we may well believe, had never before ascended to pollute this lower air. Never before, at least, had a stink risen to the height of a historic event. Even ancient fable failed to furnish figures adequate to convey a conception of its vile Augean baseness. For many weeks the atmosphere of Parliamentary committee-rooms was only rendered barely tolerable by the suspension before every window of blinds saturated with chloride of lime, and by the lavish use of this and other disinfectants. More than once, in spite of similar precautions, the law courts were suddenly broken up by an insupportable invasion of the noxious vapor. The river steamers lost their accustomed traf-

fic, and travelers pressed for time often made a circuit of many miles rather than cross one of the city bridges.

“Members of Parliament and noble lords, dabblers in sanitary science, vied with professional sanitarians in predicting pestilence. If London should happily be spared the cholera, decimation by fever was, at least, a certainty. The occurrence of a case of malignant cholera in the person of a Thames waterman early in the summer was more than once cited to give point to these warnings, and as foreshadowing what was to come. Meanwhile, the hot weather passed away, the returns of sickness and mortality were made up, and, strange to relate, the result showed, not only a death-rate below the average, but, as the leading peculiarity of the season, a remarkable diminution in the prevalence of fever, diarrhœa, and the other forms of disease commonly ascribed to putrid emanations.

“The testimony of Dr. McWilliam, as medical supervisor of the waterguard and waterside custom-house officers, is still more to the point. The former, to the number of more than eight hundred, may be said to live on the river, or in the docks, in ships, or in open

boats; and the latter, numbering upward of five hundred, are employed during the day in the docks, or at various wharves of the bonded warehouses on each side of the river. After stating that the amount of general sickness among these men was below the average of the three preceding years, and considerably below that of the forms of disease (including diarrhœa, choleraic diarrhœa, dysentery, etc.) which, in this country, noxious exhalations are commonly supposed to originate, we find the additions during the four hot months of the year from this class of complaints 26.3 per cent below the average of the corresponding period of the three previous years, and 73 per cent less than those of 1857. In another passage this distinguished physician says, 'It is nowhere sustained by evidence that the stench from the river and docks, however noisome, was in any way productive of disease. On the contrary, there was less disease of that form to which foul emanations are supposed to give rise than usual.'

"Before these inexorable figures the illusions of half a century vanish in a moment."

One nearby possibility of infection from the bath-room has been too much neglected in

the consideration of the comparatively remote possibility of more distant germ-infection, — the spilling of slops poured down the hopper by careless servants. That this provides a considerable possibility of infection through various carrying agencies, such as flies, fingers, and the like, few can question. Fortunately, the cure is directly in the housekeeper's hands. Here, as in so many other places, the woman in the home can do more than man in the seat of government to better affairs through cleanliness. There is every possibility, moreover, that unclean, ill-ventilated house-plumbing will give off stronger, more immediate, and more persistent odors than any sewer. Odors from bath-tubs and set bowls, for example, are due commonly to decomposing soap in the overflow pipe.

An analysis made some years ago of the status of the plumbing laws indicated a wide divergence of requirements made by states and municipalities. At that time only nineteen states, the District of Columbia, and Porto Rico had laws with regard to plumbing; but the large cities of most of the states had laid down individual regulations. Most of these ordinances require master plumbers to

have licenses. About a third require master plumbers to furnish bonds ranging in amount from two hundred to five thousand dollars. The majority require extra heavy cast-iron soil-pipes, running traps, and fresh-air inlets. Vent-pipes in general must be of cast iron or of galvanized wrought iron, and must extend from one to three feet above the roof.

Plumbing regulations, like many other ordinances intended for the city's health, are cursed with certain typical evils. They are indefinite, stating, for example, that certain parts of the plumbing shall be "suitable," "adequate," "properly installed." They are by no means uniform. They are stated in too complex a fashion, and they vary from the extremes of excessive caution to those of excessive laxness. They are not firmly based on the broad foundation of the body of scientific fact already acquired.

The case of the people versus sewer-gas, as originally entered, contained two charges, a major and a minor. On the evidence submitted I believe we may fairly acquit the defendant on the major charge, and declare that sewer-gas cannot produce infectious disease, through rising germs. On the minor charge, that ex-

posure to the gases of the sewer may produce predisposition to disease, the evidence submitted is still inconclusive. We can scarcely do more than register a Scotch verdict of "Not proven."

The results so far obtained, however, show us one truth of no slight importance. Where infectious disease exists, we must look elsewhere than in the sewer for its causation. That fact renders it no less our duty to insure proper sewers and a proper disposal of wastes. And this, not alone from common decency, but from the very real dangers which sewage holds. Instead of striking at a point where the enemy has made a feint, we should attack his main force at those weak points of his chain of defenses which our scouts have laid bare.

The change of attitude on sewage is one of the interesting developments of reversal brought about by an increase of knowledge. Where sanitarians formerly believed that sewer-gas, if not the root of all evils, was certainly the root of many of them, experts to-day consider sewer-gas a comparatively harmless substance, but pay the greatest attention to liquid sewage as a means of infection, — a substance whose noxious qualities are much less consid-

ered by the average layman. Filled with the possibilities of infectious disease, liquid sewage needs the greatest care in its handling and disposal. Some of the modern methods of disposal have already been considered in another place. Streams of sewage emitting evil odors and offensive to the senses cannot directly produce disease, yet it is most essential that it should be safely, accurately, and thoroughly disposed of. It is only the barbarian who does not remove sewage from the sight and smell of his community.

VIII

THE CITY'S NOISE

Now loud, now low, now sounding in musical, humming rhythm, now clanging in sharp staccato or rising in plangent, shrieking chords, the song of the city comes to the listening ear. The low, beating throb of the midnight hours, broken by the abrupt sounds of early morning, changes, as morning turns to afternoon, through the various measures of a full-throated chorus whose instruments are those of trade: the whistle, the rushing car, the noise of commerce. The theme passes, with the fall of night, into the hurrying allegro of returning thousands, threads to its web through the clatter of the evening hours, and returns at last to the low throb of twenty-four hours before. Never does it cease.

Stimulus to the morning toiler entering the city gates, the city's noise may be. To the strong, it seems the call of battle-trumpets summoning to the rush and hurry of the busy morning. As the long day wears on, inevitable

reaction sets in, the wearing grind of city-labor bears heavily on hand and brain ; and the noise, growing more and more an irritant, beats at last on the wearied ear with whips of strident steel. Another factor has been added to increase the nerve-exhaustion which is drawing so heavily on the forces of the city. A constant, if unperceived, drain upon the strong, the noise of the city may be an almost intolerable torture to the weak.

Quixotic tilting against windmills will do little more in a noise-crusade than it will elsewhere. No city can be carried on without a very considerable amount of necessary noise. A really silent city is impossible. But the unnecessary noise of recent years, the escapable noise, so to speak, has increased to a point beyond all reasonable tolerance. It is just this part of the whole that we wish to stop. Muirhead once said : " Among the most searching tests of the state of civilization reached by any country are the character of its roads, its minimizing of noise, and the position of its women. If the United States does not stand very high on the application of the first two tests, its name assuredly leads all the rest in the third." It is well worth our while to see

what we can do toward obtaining a higher percentage on the second test.

Of all the manifestations of the world about us, which our senses can perceive, many can be escaped. Sound is inescapable. The eyelids can shut out light from the eyes, the lips keep taste from the tongue, and the hand may be voluntarily withheld from touching. The ear remains open day and night to receive whatever impressions, be they pleasant or unpleasant, the outer world may send to it. Where Mother Nature has failed to protect her children, man must step in to aid.

In his consideration of the physiological effects of noise, Dr. Richard Olding Beard once made the statement that "Noise is fast becoming a neurotic habit with the American people." Speaking of the separation of sound-waves into two great classes, "noises and musical sounds, the one class characterized by the absence, the other by the presence, of the quality of rhythm," he went on to explain that the one is an irritant, the other a solace to the normal ear; and remarked that these different types of vibration not only act differently upon the ear, but actually act upon different parts of the ear's mechanism. Noise, acting upon the nervous system

of the nervously worn city-dweller, produces so real and constant an irritation that quiet becomes an abnormal state, to which exhausted nerves find great difficulty in responding.

A personal experience first showed the writer the possibility of a state of affairs where the habit of noise could become as fixed as the habit of a drug. Waking one night in the quiet of a country-house far from other habitations, I suddenly heard the starting of the hot-air engine which pumped the water, chug-chug-chug-chug. I lay listening to its monotonous vibrations, and wondering at the unusual hour for pumping, until I fell asleep. The next night the sound was repeated. On my mentioning the matter to my host, he confessed that he could not sleep in the quiet of the country, that the sudden change from the roar of a great city to the silence of the woods was so great as to cause him real suffering. As his only way to rest, he would leave the house in the middle of the night, start up the pump, and, lying down in a nearby hammock, find sleep brought him by the lullaby of the hot-air engine. That man recognized that he had the noise-habit, and finally conquered it. How about the many who are never far enough away from the

incessant tumult to know that the habit has formed? The incessant din of hammer upon iron in the boiler-shop creates a disease of the ear among the workers, known as "boiler-maker's ear." Little by little their finely attuned sensory nerves become dull and indifferent to all sound. Far more continuous than the clamor of the boiler-shop, the noise of the city is, at times, almost as deafening. The boiler-maker commonly resides far from his scene of labor, and may have thirteen or fourteen hours of rest from the sounds of his vocation. The city-dweller is never free from the surrounding din. The passage to his ear is open, sleeping and waking. More than one expert believes that a dulling of the ear to the finer gradations of sound must result in time from life spent in the midst of such surroundings. The aggregate of city noise has increased so greatly in recent years that we have hardly, as yet, sufficient data to prove this theorem. It is, at least, extremely probable.

When we come to consider the effect of noise in the sick-room, the records of the doctors appear in report after report, testimonial after testimonial. Officers of hospitals for the insane consider the increasing noise of the city

a potent factor in the recent increase of insanity, citing case after case where their attempts to cure these unfortunates have been hampered or nullified by sudden or continued noises. Dr. Hyslop of London says, in his monograph on "Noise in its Sanitary Aspect": "There is in city life no factor more apt to produce brain unrest, and its sequel of neurotism, than the incessant stimulation of the brain through the auditory organs."

Dr. Gregory of Bellevue Hospital, in a statement made at the time of the first struggle in New York to suppress unnecessary steam-whistling on the rivers, wrote in part: "Many patients suffering from typhoid, meningitis, and other serious illness, will become annoyed by the least noise or disturbance. To these, restful sleep is of paramount importance, and frequently such disturbances may cause a relapse or turn the scale against them. In many delirious patients an hour's rest or sleep may mean life. You can readily imagine the disappointment of the doctor and nurse, who have struggled to bring about the much-desired quiet and sleep, when suddenly all their efforts are frustrated as a result of the disturbing whistles."

In the quotation just cited, Dr. Gregory spoke especially of the steam whistle. In any catalogue of the causes of noise, that type must stand preëminent. Sudden, discordant, terrific in its intensity, few are the ears that can bear its sudden attack unmoved. As used in cities, it is an outworn relic of a former time, of the day when every crossing bore upon its pointing finger the inscription, "Look out for the engine when the bell rings"; when watches and clocks were high in price or low in accuracy; when such modern substitutes for the voice as the electric bell were generally quite unknown. Of the whistle of the steam-boats we shall have occasion to speak later, in our discussion of conditions in New York. It is sufficient here to bring up those twin banes of the city, the factory and the train whistle, specialized forms of noise which have been fought valiantly for years by Professor Edward S. Morse of Salem. No statement of this subject would be complete without reference to his labors.

A few decades ago, the locomotive whistle had its undoubted use in signaling, and in the warning of travelers on roads crossed at grade. To-day, on country roads it may still

serve a purpose. Its city use is ended. Compulsory gates are now placed at important city-crossings. The tendency toward compelling crossings to be above or below grade is growing rapidly. Block-systems of control and automatic methods of signaling have come into being. Every city-crossing is guarded. But the whistling continues, the strength of the noise has increased as engines have grown more modern in other ways, and the delight of employees in the use of the whistle seldom fails. Here and there, cities and towns have passed ordinances aimed at this annoyance. Some have been successful in carrying them through. In the majority of places, however, through lack of concerted action, the trains passing gated crossings at midnight wake every light sleeper, and every sick and weary soul, for long distances around, by their continued blasts.

The use of the locomotive whistle in signaling train-crews, in switching and shunting, makes life in the vicinity of a station-yard a twenty-four-hour nightmare, three hundred and sixty-five days in the year. I shall not soon forget my first sight of a European freight-yard, where all the signals were given

by bugle calls, whose clear musical notes governed the easily moving trains and minimized the attendant noise. If the American railroad man scorns the use of a bugle, there is still the megaphone and the boatswain's whistle. Much could be done by signals read by the eye. If the engineer can back his engine to the required point on the signal of the brakeman's waving arm or lantern, is there any reason why he should not respond in turn by arm or light instead of by use of the whistle? While railroad men with whom I have talked are not all agreed on this point, no small number believe that the continual whistling of the yards confuses the men at work, renders their labors more difficult, and increases the awful yearly total of maimed and injured railroad employees.

Whatever excuse the locomotive whistle may yet have for a curtailed existence, the right of the factory whistle to continue has ceased. In the old days when workmen of city factories lived grouped around their individual places of employment, it may have been necessary to summon workmen by a whistle. To-day, with the multiplication of timepieces of all sorts, with the nightly de-

parture of many city workmen to homes far from the factory section, that need is disappearing. The land about city factories is too valuable for workmen's houses. The modern corporation has no use for the man who cannot get to his work on time. The six-o'clock whistle can no longer rouse its workmen, for they, as a mass, no longer live within its call; and the workman who is at the factory on time will enter no more rapidly on the call of a seven-o'clock whistle than he will on that of an electric gong. As a matter of fact, the moment of starting work is determined by the starting of the machinery in the vast majority of factories, those which run only in the day. Since tens and hundreds of thousands of the workmen's children reach school on the stroke of nine on every school-day in the year, since they are able to enter on the call of an electric gong and pass from room to room on the pulsation of electric bells, is there any reason why their fathers should be unable to do as much? Factory after factory has abolished its whistle with complete success, yet custom holds good with thousands of others whose shrill cry brings torment to the innocent victims around.

The whole problem of whistling has been dealt with in a systematic manner by the city of Cleveland. So brief and simple are the provisions of its law, made some years ago and still in force, that I venture to quote them : —

ORDINANCE OF THE CITY OF CLEVELAND.

Sub-Division, No. 1.

Section 841. Engine Whistle. No whistles connected with any railway engine shall be sounded within the limits of the city of Cleveland except as a signal to apply the brakes in case of immediate or impending danger.

Section 842. Vessel Whistles. No person shall blow or cause to be blown the steam whistle of any vessel propelled by steam, while lying at any wharf in the city of Cleveland, or when approaching or leaving such wharf or navigating the Cuyahoga River in said city, except when absolutely necessary as a signal of danger, or in cases and under the circumstances prescribed by the rules of navigation or the laws and regulations of the United States requiring the use of such whistles.

Section 843. Stationary Engines. No person shall blow or cause to be blown within the limits of the city of Cleveland the steam whistle of any stationary engine as a signal for commencing, or suspending work, or for any other purpose except as specified in the following section.

Section 844. Nothing in this sub-division con-

tained shall be construed as forbidding the use of steam whistles as alarm signals in case of fire or collision, or other imminent danger, nor for the necessary signals by the steam engines of the fire department of the city.

Section 845. Any person violating or failing to comply with any of the provisions of the subdivisions shall be fined not less than ten dollars, nor more than fifty dollars.

A section also prescribes the signals that shall be sounded for steam-tugs.

The construction of the pavements of a city, important from the side of the cleanliness of the air, needs serious consideration from the standpoint of noise. Stop in Times Square, New York, some evening when the rush of theatre traffic is crossing the pavement, and listen to the sound. The asphalt gives back comparatively little reverberation from the rolling wheels, whose sound is continuous, regular, and rhythmical. Separate the sound of horses' hoofs from the general clatter. First in steady clicks like clock-beats, now it slows, now hastens, now stops, now quickens. Ever changing, the broken series of sounds comes at irregular intervals and produces a particularly trying type of sound-injury. The

reason for such differences in speed becomes evident as we turn and walk down Broadway. On a clear space of sidewalk our pace becomes regular, moving with precision ; when a crowd blocks the way, our movement is checked ; if a crossing intervenes, it stops. Corners, car-tracks, and blockades are constantly changing the speed of even a single horse crossing the city pavements, thereby producing noise instead of regularity of sound. Add to the noise of a single horse, passing on the asphalt, the many sounds of different horses passing at various speeds, and you have a tumult. Stone-block pavements, with their irregular junctions and broken edges, are much worse than asphalt. Macadam is comparatively quiet. Wooden blocks, such as are found on the London streets, are the best from a standpoint of noiselessness. Cobblestones are the worst of all.

Horse-transportation is but one factor in the total passing of the city. Cable and trolley-cars rattle from side to side ; motors, with their fiendish variation of whistles, thread their way in and out ; while the overhead trolley-wires, like the strings of some huge, discordant violin, never cease their vibrations. Thoreau speaks of the sounding of the tele-

graph-wires, "that winter harmony of the open road and snow-clad field." Grateful as that song may be in the quiet of the country, in the city the noise of the racked trolley-wire above adds a peculiarly trying factor to the pounding from the rocking cars below. When corporate officials desire to economize on traction lines, they not uncommonly equip the service with poor rails and wheels. The rails soon wear away. The wheels assume the shape of polygons instead of circles, and, as they turn, strike flattened angles against the irregularities of the iron rail. This is a particularly effective method of adding to the total noise. Fortunately, there is one way of relief in sight. Few devices in transportation have done more for the quiet of the city than has the increasing use of subways. Though the reverberation within the subway proper may be greatly increased, the relief on the street is marked. Only in our greater cities and along main trunk-lines, however, does the subway yet exist. The elevated, so far as noise is concerned, gives practically little advantage over the surface-car, save for the intermittence of stopping and starting, and the absence of the sound of the bell.

Pleasant as is the mental picture of chiming bells pealing out from the spire of quiet, white-walled church or Gothic tower, many of our church bells are quite out of place in the crowded concourse of men. No longer limiting its service to the brief call to prayers on the quietest day of the week, the resonant metal sends forth its summons each day and night throughout the year. Chimes tell the quarter, long peals mark each passing hour; periods of tolling ring the requiem, not only of the dead of the individual church, but of each notable man who passes away. The last necessity of the clock's telling the time audibly disappeared with the coming of the illuminated dial. The tolling of one bell among the many in a great city ceases to have significance in its honor of the dead. Yet with the multiplication of church bells, each hour brings a dozen chimes, mingling, prolonging, clashing, as they send forth their voices from their lofty spires. Intended as messengers of the doctrine of mercy, they are merciless indeed to the weak and sick within sound of their voices.

The sounding of a general fire-alarm by the use of whistles or bells serves as another reminder of a tradition quite outworn. The wild

clang of the village bell, which summons every able-bodied man within reach to fight the flames, is still a necessity of the country. City fires, on the other hand, are fought by highly trained specialists, who have no use for amateur help. The silent electric fire-alarm answers every purpose of the fire-fighters. The telephone can notify the individuals especially interested. A general alarm from bells and whistles, which calls a horde of curious gazers, is a decidedly mixed blessing as regards the fire. It is an unmixed evil in its increase of the general noise.

The barking of stray dogs and the howling of wandering cats furnish another proof of the finding of good things in the wrong place. No real lover of animals can feel anything but pity for most of the ranging dogs and cats of the city alleys and back-yards, starved, pitiable spectacles as they are. A false humanity has kept these companions of man in an environment wholly unsuited to their nature, and the wrong which men have done in prisoning these creatures of the open in the brick-walled city has produced its appropriate punishment to mankind in the resulting annoyance from their cries.

For real malignant power, none of the individual offenders against repose surpasses the milkman. Others raise their voices in the midst of an awakened city. He assumes the rôle of the waker of the early morning. Surely there must be few of us who have not been aroused by the rumbling of the milk-wagon, the running feet of the milkman, the peculiarly sharp clatter of the exchange of the empty bottles for the full, the lengthy and animated discussions of drivers meeting in the early morning. Some of the largest milk companies in New York have taken up this problem with gratifying results. Rubber-tires and rubber-shod horses, instructions to drivers to avoid unnecessary disturbance, and inspection to see that these instructions are carried out, has been more than a public-spirited move. It has been a commercial success. The average citizen much prefers his own milk delivered by a noiseless milkman, other things being equal.

It is hard indeed utterly to condemn the music of hurdy-gurdy and barrel-organ, of street-band, and of itinerant musician. The little dancing feet of the children of the poor are too seldom stirred by melody to shut this

solace wholly from their lives. Stop for a space and follow the music up the crowded slum street, and you will see an eagerness of appreciation such as symphonies do not receive. There are some quarters of the city where the organ-grinder is welcome. There are others where his coming spells torture to every musical ear. He is certainly out of place near hospitals or schools. A limitation of street-music to certain definite areas has proved possible. It would seem as if even more than this might be done. There are music commissioners in many cities. Why not turn the licensing of street-music over to them, with the requirement that with the license shall go some inspection of the quality of the music. It is said, though of this I have no definite proof, that the experiment has already been tried under the direction of a city department of police. If this elevation of the police to a censorship of the Muses continues, we may yet achieve marvels of harmony. On the whole, however, I cannot but think the music commission might prove more satisfactory.

Last, but not least, in our catalogue of noises comes the call of the street-peddler. "Street cries." That phrase, like certain chords

of music, certain fragrances of flowers, brings up a medley of delightful reminiscences. Early morning in the "Quartier," where one listened drowsily to the ancient calls of charcoal-seller and baker, of venders of merchandise who cried their wares with the very intonation of their ancestors of decades, even of centuries, ago. Afternoons in dingy London streets, hunting down the rare prints of the brilliantly colored "Street Cries of London." The roaring tide of Whitechapel, and an old church with its vivid oasis of green where we turned to the quiet of the Thames. Always the pleasant memories are of foreign lands; never of America. In their attempt to overcome the general din, our own itinerant merchants have taken to every possible means of making their presence known. Bugle calls, rattles, bells, and horns; even, in the case of one ingenious soul, the mounting upon his cart of a monster phonograph which declared in doggerel the virtues of his wares. Each strives to outdo the other, producing a general level of sound, in whose presence, as in the presence of a shouting mob, no individual voice can be perceived. In the interest of the huckster, as well as of the community, a reform already

suggested should be gladly received. It has been proposed that the principle of the common ice placard be greatly extended. The ice-man comes at the call of the card. There is no reason why all other sellers of the street should not be summoned by the same sign. Differently colored cards are proposed for every trade, and the housewife, should her community establish such an ordinance, may call her butcher, baker, and candlestick-maker by the use of signal cards which represent an extension of one of the underlying principles of noise-reform, the use of the eye instead of the ear.

Arverne-by-the-Sea has put into execution a successful plan for doing away with the extraneous noise of hucksters. In this case, an ordinance was passed which charged junkmen a license fee of five dollars unless the licensee cry, shout, or employ one or more bells or other noisy devices. If such devices are employed, the fee is fifty dollars. Five dollars each is charged other types of wagon, two dollars each to pack, hand-cart, or basket-peddler, if they are quiet. If they shout or use noisy devices, the fee is trebled. If you enter Arverne by any route, you may pass hucksters beside the road,

busily engaged in removing the bells from their carts. The appeal to the pocket-book has been successful.

Newark attacked the problem by means of a direct law, which forbade the use of bells, gongs, horns, whistles, or similar noise-makers, and went on to regulate the phonograph, a source of noise which few municipalities have been so hardy as to assail. This section of the ordinance follows:—

“Section 3. It shall be unlawful for any person, persons, company, corporation or other body of individuals, to permit or cause any sound such as that emitted by phonographs and other similar sound-producing instruments to be directed through open doors or windows into the streets or other public places within the corporate limits of the city of Newark, or permit or cause such sounds to be produced so as to be diffused in public places, within the corporate limits of the city.”

Many as are the sources of noise, the general movement against the evil was slow in starting. Recognition of the necessity of general cleanliness in the city, of control of food-supplies and water-supply, began much earlier and progressed more rapidly. Citizens could

recognize that deaths resulted from lack of cleanliness. They were far slower in realizing that constant drains upon the city's forces caused by unnecessary noise might prove a serious handicap to the total efficiency of a community. Many men, hardened to noise, scornfully repudiated the conception that it could be in any way harmful, considered objectors weak sentimentalists, refused to believe that noise could be in any way harmful to the sick, and even gloried in the increasing tumult of the city as a sign of material growth. Here and there an individual sufferer complained. Now and then some man, wiser than his generation, protested publicly. In recent years several men, Hyslop, Kempster, Lederle, Girdner, and Morse, among others, published papers and did valiant work. The American's habit of inertia in the presence of an evil suffered by all his neighbors equally with himself, hindered concerted action. Only in the last few years has the movement, which originated in New York, risen to large proportions.

Hemmed in by the North and East rivers, the long narrow strip of land which holds the crowded buildings of New York suffered from the continual torment of resounding whistles

which came from tugs and steam-craft of every type. If you were a riparian New Yorker, it mattered little whether you lived in a palatial residence on Riverside Drive, or in a crowded tenement on the East Side: in either case, you were haunted day and night by the continual shrieking. So confusing was the din that it was difficult for boats to make proper use of signals for meeting and passing. Tugs coming to wharves to take scows up or down the river would begin whistling two miles and more away, in order to waken sleepy watchmen on the docks. Boats sounded their screaming call for half hours, to call their crews from river-bank saloons. Pilots on river-steamers exchanged greetings with their friends on other boats by means of the whistle's cord, or gave salutes in honor of the servant girls in apartment houses that front the Drive. It was a saturnalia of sound.

Such a tyranny of noise on the New York rivers made Riverside Drive a natural place for the beginnings of the league against noise. To one who suffered from that frenzied tumult it was a natural step to think of other sufferers, especially of the long lines of sick in hospital, helpless before its fury. From those conditions

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sentiment, the whistling stopped in part. It was but a temporary cessation. Soon it was on the increase once more.

Here, as elsewhere, legislation proved the only permanent safeguard. There was no law which governed steamboat whistling, and the only way to reach it was by a congressional bill. Congressman William S. Bennett of New York brought forward and secured the passage of a bill giving to the supervising inspectors of steamboats the right to regulate the whistling done by boats on water under their jurisdiction. This was the first bill ever passed by Congress having for its ultimate object the suppression of noise. The bill once passed, interpretation was secured, and eighty-five per cent of the unnecessary noise due to this cause was eliminated.

The passage of the Bennett bill marked a decisive victory. Partial legislation had been secured, and the way was open to a continuance. But there was an ever-present necessity that enforcement follow legislation, and that a strong public sentiment back up enforcement, if the statutes against noise were to become effective, and not a part of the dead, useless lumber that crowds our statute-books.

Legislation, enforcement, public opinion, these are three links of a chain that breaks if any one of the three be severed. To sustain all three, "to awaken public sentiment in favor of our cause, and to aid our hospitals by diminishing unnecessary noises in their immediate vicinity," the "Society for the Suppression of Unnecessary Noise" was formed. Mrs. Rice was made president, and many distinguished Americans offered their services to the advisory board. Most important of all, fifty-nine hospitals, representing eighteen thousand and eighteen beds, had representatives on the directorate. The work of this society on the "Quiet Zone" ordinance and the "Children's Hospital Branch" deserves the imitation of other cities.

The "Quiet Zone" law in particular marked a great advance. For years an old law of New York had forbidden organ-grinders to ply their trade or hucksters to cry their wares within one block of church, hospital, or school, between the hours of nine and four. That law had been a dead letter almost from the day of its passage. It failed lamentably at three points. It was effective only in school and church hours, leaving the hospitals during

the many other hours of the day at the mercy of the passers-by. It did not mark off in any public way the space which was to represent the vicinity, thereby making enforcement at any time extremely difficult. It did not include the manifold unnecessary noises of transportation. The new "Quiet Zone" ordinance, passed last year by the Board of Aldermen, includes all noises caused by transportation, whether from horse-drawn or motor vehicles (this latter a most important point), requires the placing of conspicuous signs of "Hospital Zone," or "Hospital Street," one block away from the hospitals on all approaching streets, and enables the police to arrest any persons making unnecessary noise near a hospital.

If there is one quality of which most of us who are striving for the city's welfare need to be long, and of which we are likely to be short, it is never-failing tact. How many of us have no occasion to cry *mea culpa!* when charged with its lack? There seems to be so much to be done, so little time in which to do it. It is all the more refreshing on that account to relate the happy manner in which the difficult problem of the noise of playing children about the hospitals — a serious evil

because of the unfortunate fascination which ambulance cases have for the city child — was attacked. Watch the craning of necks and scampering of feet among the children as the ambulance hurries by, and you will understand that hospitals readily become gathering-places for all the children within reach. Arrest, imprisonment, or fine, even restriction of their brief rights in the playground of the streets, is a crime against the city child's starved nature, save in cases of real extremity. Recognizing this, and recognizing at the same time the need of the sick, Mrs. Rice, with the help of Mark Twain and the New York Board of Education, started the Children's Hospital Branch in the schools of New York.

From room to room, from building to building, Mrs. Rice pursued her quest, asking the children not only to be quiet themselves near the hospitals, but to use their influence to keep others quiet. In thousands they responded. I quote from Mrs. Rice's own story of the founding of the Branch a few of the children's pledges, each written in the child's own words:—

“I offer up this sacrifice, so as to comfort the sick near hospital and any place I know

where sick persons are, and to prevent all sorts of noises that are not necessary."

"I promise just the way a president promises to be true to his country, to stop other people from making a noise, and I also will not make a noise in front of a hospital."

"My dear Miss Rice, I promise that I will never make a noise near a hospital. Positively know."

"I promise not to play near or around any hospital. When I Do pass I will keep my mouth shut tight, because there are many invalids there. Nor will I make myself a perfect NUISANCE."

"With all my heart I promise you,
Just what you advised us to do,
I am willing to obey your plan,
To make the least noise as I can,
Before a hospital."

It would be hardly right to close this article without at least a word concerning the day which marks the culmination of the year's burden of noise. The Fourth of July, like the more local festivals similarly celebrated, has stood declared in recent years as a Moloch which claims its yearly toll of maimed and dying human sacrifice. Its sins lie open and

declared. It has been shown again and again that the change from the red cracker of the day before to the smoke and noise of the Fourth itself produces lists of killed and wounded greater than those of many battles. Those sorrowful lists tell but a part of the story. If we could estimate the death and suffering from the noise of that day, who doubts that they would stretch to appalling proportions? Three hundred and sixty-odd days in the year we shield our population from the use of dangerous weapons by rigorous laws. On two or three days we allow not only men and women, but even little children, to buy explosives of known and deadly violence without let or hindrance. The critics who call the United States "the land of inconsistencies" can scarcely point to a more notable example than this.

It is written that among the various schools of Grecian philosophy existed one known as "The Academy of Silence," composed of one hundred men, each member pledged to the purpose of the school. To them came one seeking admission. Their list of membership was closed, and their head, calling the would-be neophyte before the assembled audience,

showed him without a word an urn so filled with water that not a single drop could be added. The neophyte, reading the message, bowed silently, started to withdraw, but hesitated and returned. Picking a petal from a flower, he dropped it on the brimming bowl so dexterously that it floated without dislodging the slightest particle of the liquid. The membership of the Academy of Silence became one hundred and one.

Like that ancient member of the Society for the Suppression of Unnecessary Noise, we, who wish to give quiet and rest to the sick in crowded ward and sick-room, to little children and wearied workers, must work tactfully, steadily, effectively. Then will quiet come.

IX

CITY HOUSING ABROAD

FROM the long columns of dusty departmental reports I garnered the text which follows. Eleven thousand men in Manchester, England, tried to enlist in the army. Eight thousand were rejected, two thousand were accepted for the militia, and one thousand were taken for the army. With that record, and with the possibility of German invasion ever before her eyes, is it any marvel that Britain sees the shambling hooligan in her streets with a growing foreboding of the future? From recruiting-officers of the army, the workshop, the factory, and the forge come like tales of rejection and distrust. A remedy is needed, and that right speedily. As one part of that remedy, European leaders of both the peaceful and the militant armies are striving to better the house in which a man is born, in which he lives and dies, in a belief that environment may be closely connected with personal efficiency. They have sought the cause which has pro-

duced the defective man behind the gun or machine. They have found that housing has a direct connection with the welfare of every individual in the state.

Hardly a city but reports a desperate lack of proper housing, hardly a city ward but shows that marvelous upspringing of industries which the last half century has seen. There is a close relation between these things. I stood with a German on a height crowned by an ancient castle, and looked out over the plain below, clotted with tall chimneys. "The old and the new," he said, pointing backward and forward. "It is the same the empire over. Every year sees thousands more of those spires that mean industrial dominance to us." That little label, "Made in Germany," on the ware they send to us is but one battle-cry of modern Germany. Every one of those chimneys means that many hands are busily at work beneath, that many a head must find some lodging for the night. And good lodging is by no means as easily secured as good chimneys. Fires will not burn without good, well-built chimneys, but men and women can exist in rotting hovels.

The building of houses has by no means

kept pace with building of chimneys. From every side rises the cry of the worker: "Where can we find decent housing within the bounds of our wage?" Driven by sheer lack of quarters to the slum, many a man, against his will, adds another family to the rabbit-warrens of the tenements, crowding yet more what was already overcrowded almost beyond endurance. For it is the slum only which is elastic. The houses of the well-to-do are not the ones which expand to take in the increase of population. It is the family in two rooms, which, driven by necessity, gives up one, or, even when crowded into one, takes lodgers in those narrow quarters to help pay the rent. Thousands of slum-rooms do double duty, night and day. No sooner are the night-sleepers on their way to work than the night-workers enter, and their places are filled with sleepers once again. "Overcrowding" is almost synonymous with "slum."

Were this crowding into narrow quarters temporary, it might be better borne, but the slum has the tentacles of a devilfish. Once it receives its prey within its walls, it is loath to let them go. Suppose a laborer, sickened with the fetid air and seeing his wife and children

pine before his eyes, wishes to escape; what opportunities has he to better his condition? Even if his wage allows him better quarters, landlords and agents of better buildings often look askance at new-comers from the slums. And small indeed is the percentage whose wages allow them to spend more than the minimum for rent. From one end of Europe to the other, permanency of occupation for unskilled labor is difficult to obtain. The cry of the unemployed is heard on every hand. For many years a minimum of expenditure for shelter could be found only in the slum. It is one of the master achievements of the twentieth century that here and there doors of escape are opening even for the men with the lowest wage.

It has been often proved that the various barriers by which the slum holds its people are not long necessary. By imperceptible but rapid degrees its denizens sink into apathy, and develop that strange malady of the great modern city, the slum-disease. This is an infection productive of infections, a contagion which, as it spreads through the slum, creates new slum-dwellers as it passes, leaving its victims stricken with inertia, slothfulness, drunk-

eness, criminality. Marvelous it is, and worthy of high praise, that so many of the poor escape these characteristics. Let them escape or not, one and all suffer equally in their lack of resistance to disease. Malnutrition, bad air, and overcrowding swell the columns which tell of tuberculosis, pneumonia, diphtheria, and every kindred disease. The slum is the great culture-medium of civilization, wherein huge cultures of disease are growing, ready when ripe to rise and sweep the city streets.

Some twenty years ago Dr. Russell of Glasgow presented figures on the relation of the death-rate and overcrowding, whose brevity and clarity have scarcely been surpassed since. He divided all the families of the whole city of Glasgow into three classes. In families occupying one and two room houses, 27.74 died out of every 1000; in families occupying three and four room houses, 19.45 died out of every 1000; in families living in houses of five rooms and over, 11.23 died out of every 1000. Broadly speaking, these figures mean this: that for every two mortals who died in a Glasgow house open to sun and air and in which overcrowding did not exist, five died in the slums. Life is hard for the slum-

dwellers, but our modern cities make it easy for them to die.

Conditions are hard for the adult; they are much harder for the child. St. Mary's, in Birmingham, is less than four miles from Bourneville. Three hundred and thirty-one infants die out of every thousand born in the crowded city ward. Sixty-five die out of every thousand born in the model village of Bourneville. Every child who comes into the world in that favored village has more than five times the chance of life that the wretched scraps of humanity of crowded St. Mary's possess.

Lack of fresh air is by no means the least evil. According to many authorities we require as a minimum from eight hundred to a thousand cubic feet of fresh air per hour to keep the body-machine in efficient working order. A room twelve and a half, by ten, by nine and a half, is a good-sized room for a slum-quarter. Yet the number of cubic feet of air which it contains is less than twice the amount required for health by the average person, even if there is not a stick of furniture on the floor. Add the ordinary amount of furniture, every piece of which subtracts cubic feet from the total air-

space, and put four people in the room instead of two. How much chance does each have of getting the minimum amount of fresh air, even provided the air can be completely changed every hour?

As a matter of fact, the average slum-house abroad is so constructed that such change is quite impossible. Any one who has struggled with the windows in provincial continental houses knows that they are not made to open and shut. They are there for light, or for decorative purposes. They are certainly not there for ventilation. Not only are they difficult to open and shut, not only are the families of the slums afraid of fresh air by tradition and precedent, but the very buildings of the crowded quarters shut off the possibility of proper ventilation. Make a personal experiment the next time you walk down a narrow city street on a warm day, and notice the window-shades. Those on the top floor may be fluttering bravely, while those at the bottom are still. Fortunately for England, many of her slums are still composed of buildings which are from one to three stories in height ; but the tall barrack-buildings of the continent, which are more like our tenement houses, are in many cases as

bad as anything New York's streets can show. Ventilation on the first floor, in truth, is no simple matter in the slum. There the open window means an open entrance to the filth of the street, which is the common dumping-ground of the householders along the way.

Few external things, indeed, have been more discouraging to the workers in the slum than that same habit of dumping. And yet if the tenants of the crowded street scatter garbage, they do so chiefly because they have no proper means of garbage-disposal. Their rooms contain mixtures of food, of clothes, and of refuse; the one thing that cannot be found in them is closets for storage. Their sanitary habits are outrageous,—and no small number of English courts and German alleys provide one privy for seven or more families. Their dishes and persons are unclean. Often one faucet will supply a whole court, or in tall barrack-buildings water will be piped only to the first floor. A long trip for water tends to discourage the morning tub, and darkened rooms where sunlight never falls give little impetus to cleanliness.

Barred from sun, air, and water, those three good gifts to man, how can the people of the

slum produce men and women capable of carrying on the race? For years, light, air, and water have formed the stock example of free goods for the economist. They are no longer free in the slum. The narrow streets keep their denizens in the shadow. The high walls bar the air. Water becomes a luxury difficult of attainment. One by one the legislatures of the great states of Europe have come to understand the necessity for action. This chapter considers particularly the work of Germany and England.

Judging of causes by results, one is forced to the conclusion that the welfare of the individual German citizen is the immediate concern of the empire. The coming greatness of Germany, so devoutly foreseen by every patriotic German, seems to be the well-spring of that stupendous mass of regulations which tends to the advancement of the condition of the German unit. That is not a startlingly new doctrine, but the German attitude toward carrying out those beliefs shows many interesting applications. The German workman who is ill receives medical treatment, his family receive all necessary aid. He is obliged to carry insurance. He receives his old-age

pension when he can no longer work. All these steps, taken for the welfare of the state, tend toward the improvement of the efficiency of the individual. It is another step in this direction for the German municipality or the German state to buy land and build houses for the workmen within its borders, and to house the poor at rates which they can pay. To create a healthy proletariat, the government recognizes that it must eradicate the slum. Since it fully realizes that in this civic disease, as in cancer, the roots lie deep, it is ready where necessary to bring the full weight of its authority to the aid of better housing.

The theory that the municipality or the state should own land or buildings, and receive revenue therefrom, is older than feudalism. The lands about the castle belonged to the castle's lord. The free cities held lands and houses, but their burghers merely stood in the place of prince or baron, and received the rents from town-property as a part of the normal income of the municipality. Many a city of continental Europe and no small number of English boroughs unhesitatingly drew blood-money from foul tenements within a few years. It is only in recent time that those

stains have begun to be washed from those Augean stables by the waters of a new Alpheus and a new Peneus.

That there was need of action, a few figures from reports made about the time the movement began, in 1891, will show. In that year Berlin had three hundred and sixty-seven thousand families in twenty-one thousand buildings, an average of seventeen families to each roof. Scarcely one family in six hundred had a house of its own. Of the total population of Berlin, 117,702 individuals, or seven and two thirds per cent, lived in cellars. Hamburg was nearly as badly off in this respect. Breslau, Dresden, and Magdeburg each had nearly one half of its population in dwellings containing but one room, if we exclude the closet called the *zubehör*, which is tiny in size, has no means of heating, and small opportunity for ventilation. German families in general were housed in the so-called barrack-buildings, four or more stories in height, which corresponded fairly closely to our tenement houses. The common barrack-house of that period was wretchedly deficient in water-supply, its sanitary accommodations were foul and inadequate, and the possibilities of decent family

life within its walls were at a minimum. Despite all these things, the cost of rent was great, often averaging as high as one third the total wage received.

Recognizing that the immediate necessity was to prevent the growth of new slums, the German authorities who first took up the crusade began work by passing stringent ordinances to govern the erection of new buildings. They were aided in the successful carrying out of these measures by the great police powers possessed by the government. Stringent requirements for strength were followed by equally stringent requirements for fire-protection. Believing that the solid building-up of areas causes most unhealthy conditions, some of the governments allowed only two thirds of any building-lot in certain sections to be occupied by buildings. That regulation gave the children of the poor some chance to play, and gave both adults and children far greater chance for air and light. The dark interior room was forbidden. A sufficient number of cubic feet for change of air was demanded for every room. Water-supply, receptacles for garbage and ashes, storage for food and clothes, were brought under control

by various ordinances. But all the requirements in the world would not provide fit houses for the poor. At best such laws serve mainly to guard against the building of new unfit houses. Mere ownership of municipal land and some funds to use in connection with the work were not sufficient. There was need of aggressive tactics.

The plans of campaign pursued by the progressive German towns may be summarized under four heads: first, town planning, the use of foresight in determining the inevitable development of the cities; second, the building of model tenements that should take care of deficiencies in housing, serve as models, supply needed balance-wheels to speculation, or stimulate activity in private building; third, the encouragement of private builders and of coöperative building societies; and fourth, the demolition of the slum, either by destroying old buildings and replacing them by new model tenements, business offices, or parks, or else by such repairs of existing dwellings as would make the old houses fit for sanitary use.

Town planning is by no means a new conception, much as we have heard of it in recent

years. As far back as 1668, just after the great fire, Sir Christopher Wren proposed a town plan for London. In its provision of means of communication and in general excellence many of the details of his general scheme are not excelled to-day. He proposed that "all trades that use great fires or yield noisome smells be placed out of the town." The modern scheme sets down such removal as a primary necessity. Means of communication, by the Wren plan, were to be considered of the greatest importance, and there were provisions for streets of three different widths, all yielding easy access to the centre of the city where stood the Exchange. The modern plans lay great stress on rapid transit to and from the centre of the city, believing in general that the place where workmen should live is in garden suburbs encircling a town containing manufactories, stores, and warehouses. Wren differentiated his roads by separating them into traffic ways and residential streets. The first were to be wide, costly, and strongly built to stand heavy wear and tear, the second, narrower, less costly, and built for less arduous service. The new methods divide the streets into three classes: first, the wide expensive street through which traffic is to pass;

second, the narrow and comparatively inexpensive street; and third, what may be called the undetermined street, which may in time become a traffic-route, but which is intended primarily to be used for residences. This third type of street may be built inexpensively, may be of narrow width, and can be enlarged at a minimum of expense because of the foresight shown in its construction. Streets of this class are laid out with gardens in front of all houses. The garden-space can be added to widen the thoroughfare to the proper width, whenever it becomes necessary to expand. Compare this method with the costly American habit of building up narrow streets, with the enforced result of buying both buildings and land when residential streets are turned to traffic purposes.

Nowhere does Wren's foresight seem more prophetic than in his plans for redistricting his ideal city. Even two centuries and a half ago, men were able to understand that the close relation between cost of land and cost of rent per room of any building on that land, made it inevitable that dwellings, where offices should be, would call for office-rents. The European workman is housed to-day in many cities on land

worth from twenty thousand to eighty thousand dollars an acre. Only by building on every possible foot of such land, only by crowding human beings into every available inch of space, can tenements for the poor pay on such property. It is the general experience of foreign cities that it is wiser to replace the demolished slums by model tenements on less expensive land outside the business or manufacturing section. That this seems advisable, not only from financial but from hygienic grounds, it is hardly necessary to question.

Few things are more wastefully expensive or more naturally disorderly than a large proportion of the great cities. Huddled together without rhyme or reason are shop and factory, hovel, barrack-house, and mansion. The European custom of living above the shop has exerted no small influence on this conglomeration. By various plans the Germans are trying to sift out their dwellings from the chaotic mass, sending them into the suburbs and leaving the industries grouped in the centre of the town. That is the principle behind the plans for the encircling garden-suburb, and such ideas, to be developed by building laws, exist in the "Zone System." In this system the height of houses

and the proportion of the lot which may be occupied by a building in any section is limited by its distance from the centre of the town. The farther a zone is from the centre, the smaller the number of houses to an acre, the smaller the number of stories allowed to a house. These zones are not mathematical circles: a zone may be simply an area set apart. Such regulations naturally tend to group the factories. In Cologne, for example, buildings in the centre of the city may be five stories in height with a mansard. In outer portions of the city delimited by law, no building may rise over three stories in height, or occupy more than forty per cent of its lot. Saxony made such a scheme compulsory for all towns in 1900; and Prussia, before that time, by a suggested plan which was not completely carried out, endeavored to limit the height and number of houses in the line of the prevailing winds which blow over Berlin, in the endeavor to obtain fresh air for every part of the city. Various German communities which have taken up such schemes have developed especially the placing of houses in such a way as to obtain a maximum amount of sunshine, and have made sure that space should be left for parks, for playgrounds, and especially for "the garden

which helps to pay the rent," as one of the housing pamphlets puts it.

Few minor reforms have done more for the general health than such encouragement of gardens. Dumps and waste land have been reclaimed by the allotment system, which is, in general, the parceling out of small lots on the edge of the city to artisans who will promise to cultivate them. Prizes for the best gardens have been productive of good results. Instruction in practical gardening has interested many city-bred men and women who were ready to work, but did not know how to begin. The allotment system of distributing gardens is by no means the ideal one, however. It is the little garden behind the house which does the most, which engages the father's spare time before and after work, and provides healthful occupation for mother and child.

Summarizing the most enlightened general regulations of Germany which have to do directly with building operations, we may say that their general trend is to do away with speculation, rigidly to control the builder who is building for investment, and to give the greatest possible freedom to the individual who desires to build for himself. The author-

ities desire to encourage individuality and resourcefulness. They step in to guard the community when it is a question of building in the mass. The limitation of dividends on municipal money loaned for house-building; the leasing of lands for periods of years with the proviso that the buildings to be erected thereon shall become town property at the expiration of the lease-period; the reservation of power of repurchase and of power to break leases in cases of necessity, have all shown enlightened progress. Most of these projects have already shown fruit in model tenements containing happier and healthier citizens.

All these things cost time and money. Do they pay in human lives? Is the efficiency sought, obtained? For answer take the death-rate of one city, Offenbach am Main, which has done much for the housing of its citizens. In the ten years from 1870 to 1880 the city death-rate was 23.6 per thousand. From 1880 to 1890 it was 20.8. From 1890 to 1900 it was 18.5. In 1908 it was 14.1. Every year of the last decade has shown increased activity. Every year has seen the death-rate a little lower. In that one German city modern methods, not only of housing but of general im-

provement in standards of living, are saving from nine to ten more human beings out of every thousand to-day than were saved thirty years ago, while the gain in efficiency, in the possibilities of life, which those figures denote, is quite immeasurable.

No nation more than Germany has recognized that the bleakness and the barrenness of the tenements form one point in a vicious circle which includes drunkenness, immorality, and gambling, which makes for disease and death. None have done more in fighting the depressing effect of slum-life by the potent aids of pleasant surroundings, of gardens, music, and incentives to out-of-door life. None have understood so completely that good housing affects each member of a family, down to the tiniest babe, while remission of direct taxes, or state aid of many other sorts given to the poor, is but too likely to result in assistance to the one member of the family who needs it least, — to the head of the family, alone.

Much of the work of England has progressed along lines parallel to those followed by Germany. Part One of the English Housing Act (an act which applies also to Scotland

and Ireland) provides for wholesale clearance of slums and the erection of model municipal dwellings in their place, either on the same spot, or in cheaper land in the suburbs. Part Two of this Act provides for the compulsory setting in order of unfit habitations at the owner's cost, and for the demolishing of houses where the owners refuse to act. Houses are seldom demolished under this provision. The owners almost invariably become much interested in better housing before their time-limit expires. Part Three of the act gives power to English local authorities to buy land, erect houses, lay out open spaces for gardens, playgrounds, and parks, in much the same way as is now being done by the municipalities of Germany.

According to figures given by Nettlefold in his "Practical Housing," the cost per head of rehousing under Part One of this Housing Act varies from two hundred to one thousand dollars, averaging three hundred and seventy-five dollars. His lowest average, taken for purposes of comparison, is given as two hundred and fifty dollars. Against this is placed the cost of work done under Part Two by Liverpool and Birmingham, cities which paid

less than seven dollars per head for satisfactory rehousing. The average cost given for purposes of comparison is taken as fifteen dollars. Part One can provide better houses for a small number of people. Part Two can provide fair houses for a vastly greater number. Many of the believers in Part Two consider it safe to state that at least fifteen persons can be healthfully housed by the use of this scheme to one that can be so housed by the use of Part One.

At the very time that the Lords estranged the Commons by their revolutionary refusal of the Budget, they passed a new housing act which they had previously practically rejected. This new law involves sanitary changes of great interest. Every county council appoints a medical officer of health, who is to have general charge of the health of the county. This officer cares especially for houses unfit for human habitation. As a most important adjunct to this executive, provision is made for a committee on health and housing conditions which hears all matters of this sort coming before the councils.

Far greater powers have been given by this bill to all officials dealing with housing

questions, and tens, almost hundreds, of thousands of additional houses have been brought under the law which provides that all contracts for houses at low rents shall imply that they be reasonably fit for human habitation at the beginning and through the term of their occupancy. In case houses of this type are found to be unfit, the authorities may make them fit and recover all costs from the landlord.

Cellar dwellings and back-to-back houses are forbidden. Town-planning schemes of magnitude are provided. Powers of radical action on the part of the authorities are greatly enlarged, and many additional schemes for the betterment of the housing of the people are laid down.

Sometimes, across the riot of the street comes the call of Pan. Then heath and hill-top, dawn across the snow and the long twilight of the summer solstice, pull at the heartstrings of the city-dweller. What if a land could be where every city was a garden where children, as one poor waif once told me, "could see the whole sky," learn the world of bird and flower, and come to manhood and womanhood free from the sordid handicaps of city ways?

For those who long for "the whole sky" and trust in its beneficence, it is a pleasant duty to record some few details which deal with "Garden Cities" which have sprung up outside the smoke and grime of English towns. Underlying these various projects are basic ideas worthy of citizens of Altruria. They require that the property be highly restricted, that the number of houses built on each acre be limited sufficiently to give each householder pleasant and healthful surroundings, and that these houses shall be placed among green-swards where children may play and old people dream. They demand that all the services necessary to community life shall be rationally and wisely developed, that all building and planning shall consider both the hygienic and the æsthetic possibilities, and that the joys of country life shall be combined with the advantages of the city. Ealing, Bourneville, Port Sunlight, the Letchworth Garden City, Harborne, Hampstead, — each of these settlements contains many of the elements of the ideal garden city. Of this list two, Bourneville and Port Sunlight, owe their existence to the public spirit of two men, — Bourneville to Mr. George Cadbury, Port Sunlight to Mr. W. H.

Lever. Rivals in a worthy strife, the cottages at both Port Sunlight and Bourneville are models of architecture and sanitation. Plenty of sun, air, and water, gardens and garden-allotments, gymnasias, children's playgrounds, swimming-baths, social clubs, good schools, and neat, well-ordered shops, make both these villages of great interest to any student of the housing problem.

In 1909 the outlay on Port Sunlight was stated to have been something more than two million and a half dollars. It would have been no slight task, with that enormous expense, to make the village a self-supporting financial success; but this has not been attempted. As the houses are intended to supply homes for the workers in the Lever Brothers Company, rents have been fixed simply to cover taxes, repairs, and upkeep. The annual cost to the firm of the maintenance of the village is many thousands of dollars a year; but it is the strong belief of the employers that their expenditures here are returned manifold in the better conditions of the employees, the permanency of the staff, and the attraction of many excellent workers to the plant because of the possibilities of life in the town.

Bourneville, made over to a board of trustees as an absolute gift, by Mr. Cadbury, is increasing the scope of its original work by means of the surplus revenue in the trustees' hands. Open to workers outside the Cadbury Cocoa Works, Bourneville has, for considerably more than half its householders, men who work in other places, and who are entirely independent of the cocoa factory. From six shillings and sixpence a week to seven shillings and sixpence will house a worker well. Detached houses can be obtained at rentals ranging from thirty to forty pounds, and every tenant is a landed man, for every cottage has a private garden. This is all planted before it is turned over to a tenant, and two expert gardeners, with a staff of employees, care for the general garden-work of the village and stand ready to advise each individual householder. Is it any wonder that no tenant leaves unless he is obliged to do so, and that there is a permanent waiting-list large enough to occupy every house, were all suddenly vacated? Mr. Cadbury himself says that the great work of the future must be to enable the poor "to remove from the squalor and temptations of city life and settle amid the wholesome, helpful sights and sounds

of country life. In a word, the people must be brought back to the land."

Translate the word "land" into "suburbs," carry your people of the slum away from the pavement into the light and air on the outskirts of the town, and these sentences show the solution of the housing problem in which I most believe.

The Lever Brothers' policy of building houses for their employees, to be rented at practically nominal rents, attractive as it is in many ways, is open to serious objections. In this particular case some of these objections are met by Mr. Lever's partnership schemes. Others are basic. We have seen, in no very distant time, newspapers filled with accounts of homeless men, women, and children driven into the winter cold by general eviction from corporation-owned houses. One of the evils which has stirred England most of recent years has been the complaint of agricultural laborers: "Lose work, you lose your house." Few things make more for self-respecting independence than for a man to own his own domicile. When his home is owned by his employer, when the same period sees the loss of work and of home, the impetus to such independence loses heavily.

The action of Mr. Cadbury, who has insisted from the first on making his houses produce a fair return in rentals, who has released all personal claims to Bourneville, turned the houses over to a board of trustees, and opened the estate to all who wish to come, is far to be preferred. If corporations are to enter upon the building of houses to better the condition of their employees, they can scarcely do more wisely than to follow the Bourneville plan. If they cannot follow the great philanthropy of Mr. Cadbury, let them invest their money in sanitary houses, rented at such rates as will bring them in a fair return, and then give the control of the houses over to an absolutely disinterested board of trustees. They will thereby gain the primary object—the improvement of the condition of the workers—without leaving open the possibility of strife which may otherwise occur.

One thing more should be mentioned in this connection. There seems to be a tendency to-day towards centralization of industries, a movement by which many great capitalistic enterprises, gradually closing their scattered plants, are striving to save money and effort by concentrating in single spots. Such a move-

ment is likely to bring about a dangerous condition for the employee who owns his own home. With the consequent shifting of population, the skilled worker, forced to move with the industry and owning his own house, is left with his property tied up in a form difficult of ready realization. No small number of sociologists are, therefore, advising such workmen to invest their savings elsewhere. To-day it is at least questionable if this danger is so great that we can spare the impetus to betterment of life which comes from ownership of the land one lives upon. What ten or twenty years more will show, we cannot tell. Here as elsewhere in the city we may have to run some future danger for present good. It is possible, however, that many of the good effects of individual ownership may be secured by such modified coöperation as is shown by some of the European coöperative societies, such as the Berlin Savings and Buildings Society, which operates in and around Berlin, and the Ealing Tenants Limited, now a part of the Co-Partnership Tenants Societies, at Ealing, just outside of London.

The magnificent buildings of the Berlin society, though of the city-block type, possess many striking advantages. Sheltering in their

Häslar Street buildings as many as a thousand families, each family can obtain three large rooms for one hundred dollars a year. (The Rixdorf tenements just outside Berlin provide four model rooms for one hundred and twenty dollars a year.) In these buildings the problem of keeping the children off the street is solved by the expedient of providing sunny inner courtyards and playgrounds. Ornamental gardens were first planned, but the authorities in control soon decided that a garden of children was better worth cultivating than a garden of flowers, and the whole space was turned over for play purposes. Flowers are not neglected, however: the balconies are full of them and the whole side of the building is gay with bloom. One more point in this connection. The Germans know far more than we do concerning possible economies of space. Take the roof of a model tenement, for example. It may hold baths, lockers, laundries, playgrounds, drying-rooms, and many of the more general offices of the house.

If on some sunny London morning you should roll down through Marylebone to Paddington station and start due west from the great city, you would be headed for the most

famous of the coöperative settlements of England — Ealing. Draw a line from Harrow on the Hill to the point where the Thames makes one of its snakiest twists at Kew, place your pencil two thirds of the way down the line, and you have located it again; the point of all this geographical labor being to show the first necessity of a suburban community — proximity to the metropolis.

The Ealing Tenants Limited is a concrete expression of a belief in coöperative ownership and administration. First shares in the undertaking may be bought by incoming members at ten pounds each, and every tenant-member must take in the end not less than five shares, an equivalent to the cost of the land on which his house is placed. It is evident that, if coöperative housing is to do good to the people who need it most, money must be brought in from outside. The society, therefore, divides its capital into two parts, the shares just mentioned and the loan-stock which the society has power to issue. How this scheme has resulted is evinced by the fact that five per cent has been paid on shares and four per cent on loan-stock from the very beginning of active operation. Nor is that all. The company has

been able, in addition, to accumulate an undivided surplus to care for unexpected losses and repairs. The ideal of this community, like that of the other associations making up the Co-Partnership Tenants Societies, is to have the tenants say, "This estate is ours," not, "This house is mine." In other words, they desire to have a general ownership of the whole plant by rent-paying tenants as a body, instead of having each individual family hold the title to its own house.

The purposes of the Co-Partnership Societies which follow are well worth quoting specifically. "To secure suitable sites; to build suitable houses; to let the houses at moderate rents; to pay a moderate rate of interest on the capital invested; to divide the surplus profits among the tenant members in proportion to the rents paid by them after such charges as maintenance, depreciation, and repairs have been met; to have every tenant-member's profits paid to him in shares until the total so paid is equal in value to the value of the house in which he resides; to pay the total amount to him in cash when such equalization is secured." It would prove hard to draw up a broader or sounder programme.

Since the great mass of surplus profits is held as a part of the capital, such a system makes for the safety of capital and for regularity of dividends. Since, by the wholesale buying of building supplies, as high as twenty per cent of the total cost has been secured, the system makes for radical reductions in cost as well. As the cost of interior repairs is chargeable against the individual tenant's profits, such repairs are kept at a minimum. Since the profit to every tenant depends on the general profit of the whole, each member becomes an ardent agent for the property. Since rents in Ealing are below market-value and the tenants enjoy many of the advantages of the garden city, the task of the amateur real-estate agents is not difficult. Best of all, every member of the society is getting returns from something which costs him time, energy, and a moderate amount of money, all of which things make him value the opportunity presented to him far more than any tenant can value purely philanthropic aid.

One word of caution should be spoken before we leave the topic of coöperative effort in its various forms. The word "coöperation," as used commonly in housing literature and

as transferred to these pages, is a rather loosely defined term. It is, at best, a modification of the broader principle of genuine coöperation, which still remains a somewhat altruistic ideal.

In housing, as elsewhere in municipal reform, we are but too likely to forget the personal side. The reducing of flesh and blood to statistics and generalizations too often withers that full course of sympathy necessary in affairs which deal with human lives. The understanding of human nature which shines through the record of the achievements of Miss Octavia Hill is of especial value to the man or woman who wishes to give personal aid.

From small beginnings Miss Hill's work has spread from house to house and district to district, until thousands of dwellings owned by many different corporations and individuals have now passed into her governing hand. Invariably those houses have produced satisfactory financial returns and have provided good homes for the tenants. As an educational policy the system is almost unrivaled. Briefly stated, it follows.

The slum houses which pass under Miss Hill's control are first carefully inspected to

determine whether or not it is possible to put them in a fit condition for use. When a scheme for renovation has been decided upon, certain portions of the most necessary repairs, such as the mending of roofs and the bettering of the water-supply and drainage, are carried out. The tenants are then given an opportunity to use the benefits thus conferred, with the understanding that those who use them well will be given more, while those who use them ill will be obliged to leave. The allurements of struggling for a prize never wholly dulls to any of us. When such personal benefits are aided by a bonus for prompt payment of rent and a tactful though persistent campaign of education, a swift reformation is likely to result. Thereupon the work of changing wretched dwellings into thoroughly comfortable houses is hurried forward as rapidly as funds will admit. The money for such repairs is obtained by an equalization of the rights of landlord and tenant. Five per cent income only is paid to the owner, no matter what the return on the investment may be. At least four per cent has been steadily returned up to the present time. All money received above this sum, after charges for in-

surance, taxes, and maintenance have been met, is applied to the betterment of the houses. The tenant, therefore, has every interest in keeping up with his rent and reducing unnecessary repairs.

To obtain such results elsewhere, it might prove necessary to build up a system of control similar to that established by Miss Hill. Her collectors and inspectors are trained women, who are required to use that somewhat rare sixth or common sense, and who have developed an extraordinary amount of tact in dealing with their difficult task of training the tenants to help themselves.

Successful as are many plans for improving houses in the centre of the city, there can be little question that the great possibilities of the future lie in the development of the suburbs. No general misconception has been more insistent or unfortunate than the old one that the workman must live beside his work. Of a great part this is true, but of thousands of city workers it is untrue. The chief obstacle to suburban development is now, and will remain, the lack of a cheap and rapid transit which provides a seat for every passenger. Belgium by its development of

a complete system of inexpensive workmen's trains has already shown the way in which such cheap and rapid transit can build up a whole countryside. The progression of this kingdom on the theory that the provision of workmen's trains is as necessary a part of the functions of a railroad as the carrying on of a freight department, has produced a remarkable exodus to the country from the city. A workman's round-trip weekly ticket (twelve rides) for a six-mile trip on the Belgian railroads can be obtained for less than a quarter. Thirty cents a week will buy such a ticket to and from a station twelve miles out. Fifty cents will take a man back and forth every day for a week from a station thirty miles out. As a result of this policy, ten years' comparative record showed an increase of the number of these tickets sold from about 1,200,000 to about 4,400,000. Belgian villages by the score act as bedrooms for the workers of the city; and thus the high wages of the city are combined with the economic advantages of the country. Speaking of the work already accomplished, Professor Emile Vanderwelder wrote as follows some time ago, in an article in "Soziale Praxis": —

“Enter Hesbaye or Flanders from whatever side one may, the country is everywhere thickly strewn with white red-roofed houses, some of them standing alone, others lying close together in populous villages. If, however, one spends a day in one of the villages,—I mean one of those in which there is no local industry,—one hardly sees a grown-up workman in the place, and almost believes that the population consists almost entirely of old people and children. But in the evening quite a different picture is seen. We find ourselves, for example, some twelve or thirteen miles from Brussels at a small railway station in Brabant, say Bixensast, Genval, or La Hulpe. A train of inordinate length, consisting almost entirely of third-class carriages, runs in. From the rapidly opened doors stream crowds of workmen in dusty, dirty clothes, who cover all the platform as they rush to the doors, apparently in feverish eagerness to be the first to reach home where supper awaits them. And every quarter of an hour, from the beginning of dusk till well into the night, trains follow trains, discharge part of their human freight, and at all the villages along the line set down troops of workmen—masons, plasterers, pav-

iors, carpenters with their tool-bags on their backs."

Gather the skeins together, follow each clue to its end, and the investigator is forced to the conclusion that the housing hope of the future lies outside the city walls. The vision of the time to come shows suburbs circling massed workshops, homes set in green trees and surrounded by playgrounds and fertile gardens. Costly land is used for business. Cheap land is held for dwellings. Nor is that vision so remote and fanciful that we must consign it with a sigh to a longed-for distant day. There is a pressing problem to be solved, one that reaches up to you as you walk along the street, work at your desk or bench, or sleep in your home, — the providing of healthful homes for every citizen of the community. There is no fallacy more abominable than the one which declares that "that which is must be." Because the slum exists is no reason for its continuance. Let in the light of scientific fact upon the problem, and the waste places shall be filled and the children lift up their hands to the sunshine of a coming day.

X

CITY HOUSING IN AMERICA

IN the war-office of the modern city, head-quarters of the fight for health, for housing, and for like reform, hang party-colored campaign maps, whose tints expose the strongholds of the foe. Study one of them for a space. On streets beneath that bar of crimson rages a fell disease. There, below that spot of blue, another holds its sway. That smear of yellow covers a district where the victims of a third are dying by the score. There is but little color in the suburbs. There the white background of the map shows many a district clear. Look towards the centre of the city. As your eye runs inward, note how the stains group closer and closer together. They are deep upon the slum.

The close connection between the slum and disease is too patent for question. Some of the tuberculosis exhibits show an intermittent incandescent light burning upon the wall. Twice every minute, one hundred and twenty

times every hour, it flames and fades. Above it a placard reads: "A human being dies from tuberculosis each time this light goes out." Watch that changing filament for a brief space and project its burning through each hour of the day, each day of the year. You may suddenly remember that tuberculosis is but one of the diseases that flourish rankly in the slum.

I have spoken previously of the slum as a culture-medium of disease. To how slight an extent that is a figure of speech, the records given above may partly show. Take the crusade against tuberculosis, for example. No campaign was ever fought more bitterly, and yet authorities tell us that this disease can never be stamped out until we disintegrate the crowded masses of the city. The prison of the state and the prison of the slum are our two most overcrowded centres to-day. According to Dr. Knopf, mortality from tuberculosis among prisoners is three times as high as it is among the general population. Next to the prisons in providing fertile soil for the growth of this disease comes the chief home of the American workman, the tenement house.

The old crone in the doorway, peering through the watching group, exclaimed, "Seventeen!" as the coffin came down the steps into more sunlight than its occupant had ever seen in its former, dark, unclean ill-ventilated home. "Eight families and this the seventeenth brought out from that door. God be good to us, but it's a haunted house!" She crossed herself as I passed on, noting the number and street. The woman spoke the truth. One after another, seventeen had died in that one dwelling from tuberculosis. Nineteen in a like space was the record of another. Two hundred and four cases of the same disease occurred in twelve New York houses in eight years. And these were direct cases only. How many others were infected from the poor wretches, dying in those narrow quarters, who can tell.

"Where the sun does not enter the doctor does," say the Italians. We know to-day that the micro-organisms responsible for tuberculosis die in a few hours in cleanliness and in direct sunlight. They perish in a few days in cleanliness and ordinary diffused window-light in a light room. They will live long in darkness, damp, and filth. We know in

addition that tuberculosis is a contagious disease, whose spread is greatly assisted by overcrowding and bad air. The reason why houses are haunted by the dread plague lie open to all who know the lack of space, air, and light in the slum. Poor is the air of those streets. Poor as it is, the windows are stuffed with rags and paper to keep it out, through all the winter months. Small is the amount of sun which reaches over the high roofs of the tenement houses and falls upon the cloudy panes. Slight as that is, many are the rooms where sunlight never penetrates. New York alone has over one hundred thousand dark living-rooms, absolutely without windows; the same proud city has a little less than three hundred thousand without sufficient light or sunshine, while over twenty-five thousand New York families live in cellars. Those facts are so horrible that comment becomes superfluous.

Our foreign critics have a habit of referring to us as a nation whose methods of appeal lie through the pocket-book. Whether that charge is true or not, there is no question that he who can show a saving to the taxpayer offers one of the strongest arguments

that can be advanced in favor of any reform. The Committee on Congestion of Population in New York, in the course of its investigations, has been taking up an analysis of the budget of the city in an attempt to ascertain definitely the economic cost to tax-payer and rent-payer of such congestion as now exists, and of the lack of a city plan. The ten parts into which the committee divides its research consider the economic waste from preventable disease, the cost of hospitals, orphanages, and similar institutions, and the expense to the individual citizen of the city's failure to provide playgrounds, means of transit, and traffic-ways at times when they could be cheaply obtained. The first of these ten investigations, the economic waste from certain preventable diseases, has been completed and published. Some of its conclusions follow.

Preventable disease has cost New York from thirty-seven to forty-one millions of dollars a year for the last four years. \$166,248,408.24 is the total estimate of the wealth poured out in these four years for wasteful pain and suffering. For millions of that great total the tenement house is directly responsible. If we could only have that money for playgrounds,

for the renewing of the city! Remember that those millions represent a steady drain on the community as a whole, that your prosperity depends on the prosperity of your own city and of other cities, and that such constant leakage must affect you individually. Nor need it necessarily affect you indirectly. The child who sickens after a ride in the cars, the skilled employee whose illness means delay and loss to your business, the fellow worker whose labors must be added to your own while he is ill, the employer whose death means a reorganization that sends you searching for another position, the business associate whose loss sets back the clock of your progress, — each and all are woven into the threads of your life. The disease which affects them affects you. If housing reform cuts down the total of disease, it safeguards you.

The golden dreams of the immigrant turning for freedom and help to our shore, to that great "Melting-Pot" of which Mr. Zangwill has written, must, one fears, be doomed to some disappointment. Too often, however, disappointment turns to a tragic certainty. Suppose a little band of immigrants, leaving some continental village, starts on the ever

new discovery of the west. The entrance to this country must raise their hopes. If they come on one of the newer steamers, thanks to federal law, more space, light, and air, more healthful surroundings, are granted to the incomer on shipboard than the municipality will assure him when he reaches land. The incoming human wave which breaks upon our shores sends its scattered spray to many cities. Too little reaches the country. Too much stays in the city-slum. It is entirely natural that this should be the case, and that the entering foreigner should seek a dwelling in some locality where his own tongue sounds kindly to his ears. So the Italian, at whatever port he lands, hastens to Little Italy, the Russian seeks Little Russia, and the Hungarian finds lodging in Little Hungary.

Division of this sort makes housing problems in the United States more complex than those which many European cities show. Model tenements here cannot receive tenants chosen at random in the same fashion as can Berlin or London. Difference of race and type, even difference of locality forbids, for the Italian from the North must have his quarters separated from the Italian of the South, and one

tribe from that strange mixture of races called Russia may be the ancient enemy of another. Evidently, our attack on this problem must include some selective processes. Before we can consider general or special methods, however, we must know something of the conditions which surround us.

Laying aside for a time the vexing questions raised by such a conglomeration of types as inhabit our slums, let us see what quarters the little band of immigrants is apt to find if, as might well happen, each unit of the group is bound to some one of our great cities. Tracing the steps of each wandering family, we find that one stops at the gateway, in New York, one turns to Boston, one to Buffalo, three others south to Philadelphia, Baltimore, and Washington, while the rest push onward to the west, to Cleveland, Chicago, and St. Louis. Their separation will indicate the conditions now existing in a selected group of the cities of the eastern half of the United States.

The family which stopped first, in New York, stands the least chance of a happy and healthy life. In 1905 the state census reported one hundred and twenty-two blocks of that

city with a density of seven hundred and fifty per acre or over, and thirty blocks with a density of one thousand or over, spread over the whole of Manhattan. Since 1905 hundreds of those houses have been raised from one to four stories in height, and the total number per acre has risen in some cases to sixteen and seventeen hundred. The somewhat uncommon density of one thousand to the acre, of 1905, has become a common occurrence. What does a density of one thousand per acre mean to you reading this article in your own home? Assume that you are in a suburban house, with a lot sixty by seventy-two feet. That means ten houses to the acre. Think of the ten houses immediately around you and see whether they will average more than six persons to each house. If not, there is a density of sixty to an acre. If you are reading this in a four-story apartment house standing on a lot whose total area is three thousand feet and in which every apartment contains an average of five persons, you are taking your part in producing a density of population of about two hundred and ninety to the acre. In both these cases density is figured exclusive of streets and open spaces. When these are

included, conditions become worse. Even the last conditions cited are too crowded. What is the result when you place a thousand or fifteen hundred people where there is scarcely room for three hundred? To-day in New York there is acre after acre on which thirteen hundred persons live their crowded lives; where there are ten persons to every seven rooms; where, instead of the minimum of eight hundred and eighty feet, there is but four hundred cubic feet of air for each adult and but two hundred for a child; where only one room out of four receives direct sunlight. The immigrant who stops in New York stands but little chance of length of days under such conditions.

In its crowded districts New York presents one more example of that unfortunate state of affairs where the poor man, living on land which is far too expensive for dwellings, is forced into narrow quarters from the compelling exigency of a narrow purse. Over and over again one truism appears. House your laborer on expensive land, and you will have overcrowding because his wage will pay for but a little space. House him on cheap land, and the money which bought four walls before will buy a home. The dumb-bell tene-

ment (sometimes called the double-decker), into whose darkened doorway our immigrant is likely to pass, is unsurpassed for wretchedness in any great city of the world. Strange to say, it is an example of ill-directed reform.

In December, 1878, after a spasm of housing interest in New York, prizes were offered for plans of the best model tenement house that could be secured. To the horror of thousands at that time, and of hundreds of thousands since, the dumb-bell tenement was awarded the first prize. From 1879 to 1901 city block after city block was filled solidly with these buildings. Mistakenly advised as a model plan to builders who knew no better, fulfilling every purpose of the man who was ready to exploit human lives for money, the dumb-bell tenement is responsible for an appalling roll of deaths, and for an extraordinary waste of efficiency. Its name is derived from the fact that it narrows in the centre and expands at the ends like a huge dumb-bell, and its expansion fills the street both front and rear. Its narrowed centre gives room for that misnamed feature, the air-shaft. That shaft has been variously called a garbage-hole, a dirt-trap, an ash-bin, and a destroyer of privacy. It has never proved

its right to the name of air-shaft. Without an intake at the bottom, how long would any chimney draw? The air-shaft is like a chimney without an intake. It is but one of the evils of the dumb-bell. Seven stories high, with four rooms in the front apartment; three rooms in the back; with one room of the front apartment open to the street and one room of the rear apartment opening on twenty feet or so of back yard; with inside rooms facing on an air-shaft whose wall is less than five feet away from the windows of the next house,—these are some of the characteristics of the habitations which house a large portion of the citizens of the greatest city of the Western Hemisphere.

The building of the dumb-bell tenement was stopped in 1901, and regulations providing for the erection of new-law tenements, with large courts designed to provide natural light and ventilation for every room in the house, were made. No window was to open within twelve feet of any other window. The practical results of this law have hardly equaled its theoretical possibilities. In October, 1908, the Committee of One Hundred held a Citizens' Exhibit showing conditions in New York

under Tammany. One of the placards on the wall read as follows: —

THERE ARE IN NEW YORK APPROXIMATELY 300,000 LIVING-ROOMS WITHOUT ADEQUATE LIGHT AND VENTILATION. ONLY ONE IN FOUR OF THE ROOMS IN THE NEW-LAW TENEMENTS HAS ADEQUATE SUNSHINE. ON MAY 1, 1909, THERE WERE 16,006 OLD BUILDING VIOLATIONS SLEEPING IN THE CORPORATION COUNSEL'S OFFICE. 1563 CASES WERE OVER 4 YEARS OLD. 2283 CASES HAD BEEN NEGLECTED ONE YEAR. 4578 CASES HAD BEEN NEGLECTED OVER 6 MONTHS. THERE WERE 35,000 VIOLATIONS OF THE TENEMENT-HOUSE LAW ON THE BOOKS OF THE TENEMENT-HOUSE DEPARTMENT. BLAME TAMMANY FOR THESE CONDITIONS. AND FOR YOUR HEALTH'S SAKE —

VOTE TAMMANY OUT!

That placard is but one more example of the oft-told tale that regulation without appropriation and enforcement does not regulate.

No part of our group of immigrants is likely to suffer so greatly as the family that stopped at New York. The new-comers who came to Boston have a wider choice, but they may find lodging in certain quarters of the city where conditions are fully as bad as any in the greater community. There is more opportunity for proper housing, should American surroundings so improve the family's financial condition as to

enable them to move into the far more accessible suburbs. Those who live in the centre of the city must crowd into houses with but little more light and air than they would get in the dumb-bells of New York. The bovine street superintendents who are said to have first laid out Boston's thoroughfares did a poor enough piece of work in the business quarters of the city. They did their worst in the old North End, whence once the finest residences of the city overlooked the bay; where now are slums, whose narrow winding alleys cut off whatever advantage of light and air the houses, lower by two or three stories than those of New York, possess. Nor is overcrowding any better in lower houses than in higher ones. There are 1672 persons on an acre in five and six story houses in New York. There are 1143 persons on an acre in three and four story houses in the North End of Boston.

If one could imagine the head of a family, which goes west, studying the figures which tell of congestion of population, Chicago, with its average density of only 21.09 to the acre, would seem a free and open city for him to choose. These figures, however, are most misleading. The city of Chicago contains

122,011 acres within its limits. Thousands of these acres are but sparsely settled. Tens, almost hundreds, of them in the centre of population are either overcrowded or on the edge of overcrowding. Congestion in Chicago is developing with amazing rapidity. In an investigation of six selected blocks, one half had three persons to a room, one fourth had two persons to every room. That means that, if two rooms are occupied by four people, all four are commonly in the bedroom at night. Such overcrowding is not all. Add to it the tendency to cover eighty or ninety per cent of the whole lot with dwellings, and the chance of air and light grows small indeed.

Lot-covering is not peculiar to Chicago: it exists in all great cities. Profitable to the purse of the landlord, it is wasteful of the life of the tenant. Every built-up yard drives children to the street, cuts off light, and obstructs the current of air. According to many experts there is no central city lot on which dwellings should cover more than from sixty-five to seventy per cent of the total area. More open space may be advisable, depending on local conditions. Less open space does harm to the city.

St. Louis gives no great promise to the new-comer. In an investigation recently carried on by the Civic League of that city, one half the houses in the negro quarter were declared unfit for human habitation. The Polish quarter had an average of thirteen persons to four rooms, and a number of lots were found which were wholly covered by buildings. Cleveland reports that one third of all the buildings in one of its slum-districts should not be permitted to exist. Philadelphia, the vaunted "City of Homes," specializes in one-room "housekeeping apartments," where whole families, often containing from four to seven members, eat, sleep, cook, and live in a single room. Buffalo presents a Polish quarter, whose buildings are chiefly small, individual, wooden houses seldom more than two and a half stories high. This city offers an interesting proof of the fact that overcrowding is not synonymous with high brick tenements. In its frame houses live thousands of Poles, who crowd together like bees in a hive. Two, three, four, five, even six and seven families gather under the same roof in small houses whose space is no more than sufficient for a single family. Such buildings, however, have one great advantage over

the ordinary tenement. They are open to the air.

In both Baltimore and Washington the alley-problem is the most pressing evil which needs reform. Alley-house and rear tenement alike offer one great barrier to correction: they are out of the public eye. Sanitary reform is difficult behind a sheltering screen, and it has no more active agent than publicity. So long as noisome alleys and rotting rear tenements exist, so long will vice and crime find a home and a citadel whence they may sally forth. Either of these conditions can find but one remedy, demolition. They cannot be cured by halfway measures. Centres of decay, the knife is the only way of cleansing the body politic from the corruption which they engender.

The various characteristics of the slums, high death-rate and premature old age, moral degradation, drunkenness, and thriftlessness, difficulty of family life and utter lack of community spirit, are produced by a mixture of causes. The tenement house and its allies are not alone responsible for all these things. Poor food, water, and air, drunkenness and gambling, each of these plays its part; but, overcrowding is a powerful factor which is

the genesis of many other evils. So long as the slum exists, the piers of our city structures must rest on quicksand.

How largely topographical conditions influence the making of a slum is hard to tell. Manhattan's long tongue of land, fenced in by its limiting rivers, is very probably responsible for some part of the overcrowding of New York. It is hardly fair, however, to throw the whole onus of blame on topography alone, when such serious conditions obtain in other cities. Mr. Lawrence Veiller considers that a large part of the trouble came originally from the short-sighted policy of the authorities, who utterly neglected to provide dwellings for the horde of immigrants who have poured through the open gates of the continent for so many decades. Enforced regulations have long been lacking. Slipshod methods have enabled evils to gain the upper hand, and have produced their ill results in housing, as in other city needs. So long as man is allowed unchecked to wring exorbitant profits from the scanty pittance of the poor, so long will men be found to do it.

Much of the necessary body of building regulation has been outlined by American

and foreign experiment. It seems an absurdly evident proposition that the area of air-shafts and courts should increase in proportion to the height of the building. Even a child, building a play-house in a pasture, will enlarge its area as the rock wall goes higher. Even a child has wisdom enough to see that the higher wall will cut off sunshine from the ground within, if the space be narrow, and that his room will be damp and cold in consequence. The child in carrying out his building operations shows more intelligence than the combined wisdom of many municipal departments displays. They have not yet awakened to the fact that every additional story of a building, rising into the air, necessitates larger open spaces on the ground. Back-to-back tenements, which quite forbid thorough ventilation, may still be built in many cities; lots may be wholly covered with buildings; rear tenements may be placed behind front tenements; and when, as in the case of New York, houses are built originally at the back of a lot, with a front garden, the march of building movement may fill such garden-spaces with brick and mortar.

There is no great difference in the need

of light, of air, or of water in the case of a tenant who lives in Chicago, in Pittsburg, in Washington, or in Boston. General sanitary regulations for general needs may be made which can cover any city; yet local conditions, topographical and sociological, must determine local laws. The twenty-five foot lot binds New York to a definite procedure. The desire of tenants in many quarters to have one room open on the street makes impracticable in this country some of the inner-courtyard plans which have been successful abroad. The longing for street windows is probably due to the fascinations of the unfailing picture-show of the city street, which seems never to weary the observers who, with elbows crossed upon the sills, crowd their casements for hours. Give them far greater measure of convenience in other ways, give them double window-space, opening on a courtyard, and they will still long for the sights and sounds of the street. Moreover, the intangible chains of social procedure are powerful in the tenements. In many districts the occupant of a rear tenement which does not look out upon the street is considered the social inferior of the occupant of a precisely similar apartment with street frontage and situ-

ated on the same floor. Ridiculous! Yes! But is it any more ridiculous than some of the rules of precedence nearer the top of the social ladder? Since such conditions exist, it behooves the reformer at least to recognize strong barriers of social prejudice, which may be easily evaded but hardly surmounted.

Among the more general housing regulations, there are two for which the city is especially responsible, the service of municipal water and the protection against fire. That such primary necessities of existence as water-closets should be used in common by whole tenement houses is one of the burning shames of our community life. There are numerous tenement houses to-day where water has never been put in above the first floor. Imagine shopping without an elevator, and then think of the weariness of those long flights to tired women and little children! Even where water is piped to every floor, a common water-closet and a common sink often supply the needs of four apartments, which may house from eight to twelve whole families, to say nothing of lodgers. In the slums, as too often in apartment houses far from the slum-classes, the water-closet ventilates on an air-shaft used also to ventilate bed-

rooms. In still other cases the water-closet is placed directly in the bedroom. Manchester, England, requires that every room used for such purposes must have a window opening on the outside air, with an area of at least one foot by two. Detroit requires that the water-closet compartment be open to the outer air, or be ventilated by a shaft which is not used for ventilating any habitable room. Several cities demand that no water-closet shall be placed in the yard or the cellar. Some of the most enlightened have reached the point of requiring one for each family or each separate apartment. In general, the infamous "school sinks" and other cheap substitutes for modern plumbing are forbidden. Violations of these ordinances, however, like those of many other laws made for the protection of the city's health, are far too common.

That cleanliness is not a necessity of existence has been proven by the slums for many years. It is a forbidden luxury to most of them. That it is necessary for healthful life, few will deny. The way to provide opportunities for cleanliness in the houses of the poor is by no means settled, but the great mass of opinion is on the side of the individual set tub. Nor need the

tubs be confined to clothes-washing alone. A movable partition and stout supports improvise a bath-tub which, though scarcely as convenient as a porcelain one, is by no means to be despised where space and cost must be considered. If clothes are to be washed, it is practically a choice between the coöperative laundry, to be used in common by all tenants, and the individual set tub ; and the coöperative method has shown one interesting example of failure which hardly encourages its adoption.

The coöperative laundry built by the London County Council for their Boundary Street buildings, at an expense of over fifty thousand dollars, has never from the first proved a success. The tenants of those buildings would not wash in public where their neighbors could see and criticise the quantity, quality, and appearance of their clothes. There appeared to be no objection to hanging out the clothes to dry in a common space after they were washed, but the preliminaries must be done in private.

I have seen one tenement-house fire : I hope I may never see another. It was an object lesson which makes the heading, "Another Tenement-House Fire. Two Lives Lost," a real and vital thing which overshadows even

politics and the financial page. That is such a common heading, too! How common was shown vividly by the investigation of Hugh Bonner and Lawrence Veiller a few years ago on the relation between tenement houses and fire. All the records of fires which occurred throughout the city during a period of two years and a half were examined, to determine the type of buildings in which most of the fires occurred. Sixty thousand records were searched to determine the general method of the spread of fires in tenement houses. Nearly one half of the total fires, during the period chosen, occurred in tenement houses, although this type of house composed but thirty-seven per cent of the total buildings of the city. Forty-two per cent of all the buildings of the city at that time were dwellings holding not more than two families, yet such dwellings furnished only fourteen per cent of the total fires. The tenement house is more than a centre of infection : it is a fire-centre as well. The way in which the flames spread in the cases of serious tenement-house fires shows how much destruction and loss of life is due to construction. Twenty-six per cent of all such fires spread through

the air-shaft; five per cent through the air-shaft combined with the halls and stairs; twenty-four per cent through flooring or partitions; twenty per cent through halls and stairs; one fourth of all the fires started in the cellar. From those figures, taken in New York, we may obtain an indication of the lines which should be taken in freeing the tenements from this scourge.

Fireproofing throughout is, of course, the ideal solution of the fire-problem. It is very doubtful if it is practical in the tenements. Construction of this sort is so expensive that its general application would mean a rise in rents and a consequent diminishing of other necessities which would make conditions worse than they have been. The analysis of Bonner and Veiller just cited shows three points which need especial protection — stairs, hallways, and shafts. If those natural chimneys can be safeguarded, if we can obtain fireproof floors and fireproof partitions between cellars and first floors, we shall have eliminated no small portion of the probable difficulty.

After all those changes have been made, however, enough has not been done. Interior egress is not sufficient; exterior egress should

also be provided. In only too many cities, the laws which require adequate fire-escapes have been systematically ignored; only too often when escapes have been raised, they have been wholly inadequate for their purpose. At the time of the investigation just cited, there were approximately two thousand persons in one New York ward living in tenement houses wholly without fire-escapes. In the same district were many fire-escape balconies constructed of wood, which would burn out at the first blast of flame. Household goods and flower-pots blocked sudden egress in case of sudden fire. Many of the escapes were vertical ladders. A vertical ladder is safe enough for an active powerful man, but the great majority of the population of any given tenement house is never composed of such men. How much chance do women and children have of gaining the ground in safety and in good order by such means? Talk with the firemen and they will tell you that a vertical ladder fire-escape generally means that they must carry the women and children to the ground while the conquest of the fire must be delayed. Sometimes the battle is lost because of that delay. Fire-escapes made

wholly of metal, with stairs bordered by hand-railing, provide the only safe method of escape from the crowded dwellings of the slums. It is no less than a city's duty to demand them. Nor should fire-escapes on the larger tenement houses be limited to the rear. Kitchens, commonly placed in the rear of an apartment, are favorite starting-places for fires, whose flame may easily envelop a rear escape as well as the stairs. Under such circumstances, the only safety comes from the possession of escapes both front and rear.

The initiative in the movement for reform may come from single or collective forces. Private citizens can do much to aid. The wonderful work of the tuberculosis exhibits can be duplicated by good housing exhibitions prepared by societies interested in civic reform. Coöperative societies have fully as great a chance to build model houses here as in England, where so much has been accomplished. Capitalists, who desire to aid the poor by methods of self-help, may find work ready for their hands. Labor unions, which have done no small part of the whole work so far accomplished, can do much more. The

greatest necessity of all is for a constant persistent campaign of education.

After all the general work has been done, however, each individual city must find the values of the many unknown x 's of the housing problem by the use of the known factors, the a 's and b 's, of its personal equation. The initiators of such movement have a large field to cover. Only when all the facts and figures furnished by local and general conditions have been secured, only when all the data obtainable with respect to the work already performed is at hand, can we hope to find firm foundation for our arguments. It is entirely probable that the best way for municipalities or associations to take up this question is by means of a temporary committee or commission, whose membership should be made up in the way pointed out by the best foreign examples. Some of the governments abroad have obtained the services of experts in the six lines of work most closely connected with the housing problem. Their commissions include a doctor, an engineer, an architect, a real-estate expert, a builder, and a social worker. There are too many problems of disease, too many problems of construction, too

many problems of finance, and too many personal problems, for any of those experts to be safely omitted.

Such a board would, of course, proceed immediately after its appointment to obtain the necessary facts and figures for its labors. A house-to-house canvass should be immediately begun, not only for the purpose of determining to what extent evil conditions exist, but also to find out what deficiency of housing exists in the city. While this canvass proceeds, a general investigation of the land in the slums and around the city should be undertaken, to determine what localities exist where inexpensive and easy means of transit make access to work comparatively simple, and where land can be bought cheaply. The collection of data from American and foreign states, cities, and private enterprises is important. Its arrangement and cataloguing in such shape as to make access easy is quite as necessary. Each of the specialists on the commission should report individually on his own line of work, and bear his part in the general statement to be issued by the whole commission. Experts should add to this such a digest of existing law as to make it evident, at the close of the house-to-house

canvass, just what the law is and just how completely it has been enforced.

The assessors' books provide a starting-point for housing investigations, since they are the register of house property of every kind situated within the city limits. From these books may be learned what land is too costly for dwellings and what land is cheap enough to be used for this purpose. That point can scarcely receive too great emphasis. If houses are to be available for the poor, rents must be so regulated as to meet the lowest average wage. To know the practicable rents for any city, the wage-statistics of that individual city, not the general statistics of a country, must be obtained. In no civic problem does the personal equation of a city affect the result more. A second point follows naturally here. The regulations imposed on persons desiring to build must not be too costly. They must always seek to give the maximum health-protection at the minimum cost. The desire for harmonious artistic development is most laudable. If it can be secured without hygienic loss, well and good; but when the beautiful and the healthful conflict, it is the æsthetic side which should suffer. There is no finer ornament to a city than healthy boys and girls.

One must hesitate a long time, however, before advocating the policies of Germany and Great Britain in the United States. Municipal ownership of dwellings, which may be to some degree successful under the autocratic rule of the first nation or the parliamentary control of the second, may be of dubious value here. The average municipal officer would be too hesitant in applying sufficiently rigorous methods of control to a tenant of city property who had helped in his election. The possibility of colonization in municipally-owned dwellings would be too great. The danger that a man's home would be used as a club to control his vote would not be small. Most of all, our lack of those distinctive classes which make houses exclusively for the poorer classes possible abroad, makes houses for any class impossible here. However contented with his former lot the immigrant may have been, the air of this country soon leads him to hope and dream of advancement for his children, if not for himself.

Municipal housing considers but one phase of the question at best. There are many other ways in which municipalities can do much to encourage the building of good and inexpen-

sive dwellings by individual citizens, and by coöperative societies or associations.

The common practice of remitting taxes to manufacturers, who are willing to increase the prosperity of a town by bringing new business within its limits, is a precedent for similar action to builders willing to put up model houses at low rents. The heavy cost of betterments, of sewer-opening, and of street-making might be waived in the case of contractors willing to supply housing deficiencies under strict regulations. Such remissions should be charged to the builder, and waived only during his performance of the necessary conditions. On violation of the regulations, or on the raising of rents above the stipulated sums, such charges should become automatically due. In the present competition of town with town, boards of trade are sending advertising matter all over the country in their efforts to attract citizens and manufacturers. Could a board of trade offer a better drawing card than a good town plan? Could they furnish many greater incentives to a manufacturer than would be provided by well-planned houses for employees? No organization could work more effectively in obtaining the back-

ing of public-spirited citizens ready to further housing schemes.

Of the close relation between rapid transit and housing, Charles H. Cooley wrote some years ago in one of the papers of the American Economic Association : —

“ We must recognize in the system of urban transportation a definite social organ, having for its function the distribution of population about industrial centres. It is an industrial necessity that men shall work in dense aggregates. Humanity requires that they shall not live in dense aggregates. The conditions of industrial life are such that the number of aggregated workers necessarily increases relatively to the number of scattered workers. There is, then, a conflict between the industrial tendency to aggregation, and the needs of humanity. The function of city railways is to reconcile these conflicting requirements of the social organism.”

To bridge the gap between the workshops of the centres and the homes of the suburbs, cheap and rapid transit must be provided. That transit, if it is to be of use to those who need it most, must especially consider the length of time which the worker will spend

in passing to and from his labor. Suppose we start with the assumption that a trip of half an hour each way, an hour a day given over to travel, is the most that the average workman will give to travel to and from his work. That hour is not a fixed period based on statistical information. It is rather a general statement made to serve as a reasonable standard for the development of a theory. The half hour of the single trip should include the time taken to go from his home to the cars, from the cars to the factory, and necessary waits for the cars. Surely it does not seem excessive to say that the average workman will be obliged to spend ten minutes of his half hour waiting and getting to and from his means of transportation. That leaves twenty minutes to be spent on board the cars. On an electric surface car, at the hour at which he travels, that will scarcely take him, at best, more than four miles from his labors. With the blockades of the streets it is likely to carry him a much shorter distance in the given time. The great city has tried the surface car (still available for the small city) and found that it will not give the rapid transit that its citizens must have. Under the best conditions such

railways will not take the workman outside the crowded quarters in the time that he can spare.

An elevated system will do far more. A two-track system, however, at the rush hours, has its cars crowded to the doors and is forced to comparatively frequent stops. It will not open an area of sufficient size to provide space for the people of the crowded centres. Four-track elevated systems in the narrow streets of many of our larger cities are an impossibility. The only spaces left for railway locations in the centres are underground or above the high roofs of the sky scrapers. Airships are hardly practicable for workingmen's transit as yet, and the four-track subway with two tracks for accommodation trains and two for express trains seems to be the best means of traveling back and forth. Only by swift expresses can we open an area sufficient for modern city needs.

We are sometimes likely to forget how close is the relation between the rapidity of transit and the area available for buildings. It is even more difficult to realize how swiftly that area grows as the speed of the trains increases. Estimating the average rate of speed of the

different types of city railways, for purposes of comparison, as ten miles an hour for surface, twenty for a two-track elevated system, and thirty for a four-track subway, will give us some light on the relation between the two factors. Consider the unit which we proposed, the possibility of the workman spending twenty minutes on the train, and you will see that the surface railway will carry him three and a third miles in that time, the two-track system six and two thirds miles, and the elevated ten miles. If we could obtain radial systems running into circular zones about the city, we should find that the area in square miles would develop amazingly as we increased the rate of speed. The surface railways would serve an area of about thirty-five square miles. The two-track an area of about one hundred and forty square miles. The four-track, with its express trains, an area of about three hundred and fourteen square miles. And this progression in size would be due to the geometrical fact that the areas of two circles are to each other as the squares of their radii.

The steam railways can do much in distributing the population, but their general use is limited in three ways: first, their compara-

tively small number, second, their inadequate terminals, which commonly require a long walk after the workman reaches the city, and, third, their fares graded on distance. The number of the steam roads around the towns does not seem likely to be greatly increased. The steam railroad, in America, is essentially a long distance line. Its suburban traffic moves along the long path of the road's journey to its final destination. The short branch lines which serve suburban populations are largely projects of a former day. It is to the electric road that we must look for the development of our suburbs. Steam roads are likely to have poorly placed terminals for the development of workmen's traffic, and the difficulty of passing from one terminal to the different parts of the working quarters or to the terminals of other roads is often great. In this respect we might well take advantage of the example of Berlin, whose four-track belt line, encircling the city, joins terminals and leaves passengers near their destination. Of the problem of the graded fare, the third limitation, we shall speak in another paragraph.

Cost of transit is no less important than rapidity. Rapidity of transportation will do

little for the city, if its expense prevents its general use by those who need it most. The steady expenditure required by the movement to and from work, even at a five-cent fare, is a serious steady drain on the workman's purse. In these days of the high cost of living, the weekly sixty cents means much to a man with a limited wage. Speaking of this topic, A. F. Weber, at the close of his work on the "Growth of Cities," gives, "Four goals which are of fundamental importance. (1) a shorter working day, which will permit the workingman to live at a distance from the factory; (2) associations for promoting the ownership of suburban homes by workingmen; (3) cheap transit; (4) rapid transit." Of the third of those goals, Cooley has said, "The lower the fare, the wider the area open to the man with the light purse."

It is worth noting that the London County Council, in its Millbank buildings, provides transportation with a *seat* for every workman at a rate of two cents per trip. Contrast that with the average condition here. The waste of opportunity in our granting of franchises has been great in many directions. In none is it more apparent than in the neglect of

American cities to impose such conditions upon petitioning corporations as shall provide opportunities for workmen's dwellings in the suburbs. Railroads and trolley-lines should be required by charter restrictions to run workmen's trains and cars at reduced prices at convenient times.

It may be that our freedom from class conditions makes it impracticable to run trains for any given class. If so, is it too much to ask that at workmen's hours, trains at reduced prices shall run, which are open to all classes? The majority who use them will be the ones who need them most. There will be slight probability of empty seats, and the assurance of full trains should make it possible to base fares on actual running expenses. If reduced prices are to be granted, however, they must be based, so far as possible, on a uniform fare. Urban railroad fares, graded on the distance traveled, have not found great favor in this country. They offer a serious obstacle to sending of the workman far from his work into healthful surroundings, for they set up a series of artificial barriers at the limits of each payment. A limit, beyond which an extra fare is required, is difficult for the slen-

der purse to surmount. It offers too great an inducement for the traveler to stop at a point which can be reached by one of the lower fares from which he proceeds no farther.

Projected lines should insure that possibilities of housing be not neglected. This second requirement can be fairly imposed only by such an expert commission as that mentioned, which can examine proposed routes with relation to their housing possibilities.

Surveys of general conditions, and recommendations of definite laws, may do much; but to make such work lasting, some permanent body must be provided which shall deal with housing as a permanent city department. The construction of such a department, and the regulations under which it should act, should depend upon the information obtained by the preliminary body. A single department having in charge this one branch of civic life should be instituted in every city where a bureau of this type does not exist. Such government as the slum has so far received has shown the disadvantages of a multiplicity of controllers, all too engrossed in their immediate affairs to pay much attention to this side-issue. The police, the fire department, and

the department of health have each had a share of the control. Between them all, little has been done. The tenement-house bureau of New York, ineffective as it has been under Tammany, is yet far better than the older methods which divided responsibility. But a housing department, if it is to have any value, must be backed by sufficient appropriations. The spirit of the people must be behind the movement. New York's experience, as evidenced by the placard cited near the beginning of this chapter, has shown of what limited value legislation can be when these things are wanting. The city must guard against nullifying such reform by legal intricacies or verbiages. The first necessity of the laws or ordinances under which such a department is to work is simplicity. The wording should be intelligible, not only to architect and builder, but also to any intelligent layman. Owner and tenant alike should be able to understand each and every paragraph. Fortunately, moreover, if we grant the postulate of a rightly constituted department, with sufficient appropriations, we shall find ample possibility of enforcement in the city's hands. If the housing authorities refuse to allow tenants to oc-

cupy a new house until all the necessary regulations have been met, builders become extremely anxious to meet requirements. The closing of a few houses which are unfit for human habitation and the refusal of permits to occupy them until they have been properly renovated bring about rapid repairs. Opposition to public control of private property is inevitable, yet the swiftness with which so great a movement for the city's health has prevailed seems sometimes incredible. Every attempt which has been made to secure protection for tenants has been opposed by two classes of hostile building interests,—the honest builder and the reckless speculator. Many of the first class, who have been sufficiently public spirited to accept changes which are for the good of their fellows, have been brought to see that properly built tenements are a better investment than poorly built ones, because of the permanency of the tenants and the minimizing of repairs. The speculator who throws up a jerry-built house for the sole purpose of unloading it on some confiding investor at the first possible moment, needs no protection. The community needs protection against him as against any other sharper.

To the honest landlord who objects to the apparently arbitrary control of his property, there is but one reply: he must endure that control for the good of the community. In like case, more than one honest milkman has objected to a board of health which required inspection of all his milk-supplies. His good milk must be inspected with the bad. The individual has no right to market wares that injure the health of the community. No landlord can hold property without assuming liability for such betterment assessments as the city may think it wise to make: his possession of property implies his assumption of liability to protective governmental measures. Fortunately, the final tribunal of this country, the Supreme Court of the United States, has already determined the right of a state to say to its citizens: "You shall build in accordance with our laws and in no other way." When the Massachusetts legislature divided Boston into certain divisions and limited the height of the buildings in those divisions, buildings in the residential quarter were required to be less in height than those in the business district. A citizen desiring to erect a building of a greater height than that allowed for cer-

tain sections of the city decided to test his rights, and appealed his cause from court to court. He lost his case. This affirmation of the right of a city to protect its citizens by its control of the building of their habitations makes this a decision of the greatest importance.

The great books whereon are blazoned the achievements of our American cities are still in the making. Turning the pages slowly, one finds many an illumined scroll, many a fair full line. Side by side with those noble records stand blotted paragraphs where shame has ruthlessly despoiled the workman's careful task. Here and there a sentence well begun has trailed off into vague traceries which carry no message to the eager searcher. Turn to the page on which the American city's contribution to this great world-problem of housing should be entered and you will find it scarce begun. The filling of that page will be forced upon us, on you and me, in the coming years.

NOTE. At the close of these two chapters on housing I feel that I should express my appreciation of the information along these lines given me by Mr. Edward Hartman, Secretary of the Massachusetts Civic League; by Mr. Benjamin Marsh, Secretary of the Committee on Congestion of Population in New York; and by Mr. Ernst Parsons, of Somes and Parsons, Architects, Boston, Mass.

XI

A SELECTED BIBLIOGRAPHY

THE bibliography which follows is designed to be, as far as possible, a bibliography of accessible books rather than of articles which might be difficult for the reader to obtain. It is wholly an English list. It represents, as has been stated in the Preface, the genesis of much of the material used in this book. In the consideration of three subjects, noise, ice, and sewer-gas, the general rule, given above, has been broken because of the limited number of books on these subjects and because of the fact that these are stories of individual effort. The journals which have been chiefly used in the preparation of the matter are included in the first list given. The Departments of the United States at Washington have furnished a great number of pamphlets on many different subjects. Most of these can be obtained by any citizen upon application to the Superintendent of Documents, Washington, D. C. Their titles are not generally

included here, as they can be obtained, upon request, from the proper officials. The registry departments and departments of health of various cities have supplied much information. Other material has been drawn from the twelfth census, from the "Bevolkingsstatistiek" of Amsterdam, published by the Bureau Municipal de Statistique of Amsterdam, and from Newsholme's "Vital Statistics," published by Swan, Sonnenschein and Co. of London. The Society for the Suppression of Unnecessary Noise furnished a considerable part of the material on noise. The bibliography on ice, included in the Memoirs of the American Academy of Arts and Sciences, vol. xii, No. 5, is of especial value to the student of this subject. Richards and Woodman have an excellent brief bibliography relating to the subjects of their work in their volume on Air, Water, and Food, mentioned later in this chapter.

JOURNALS

American Journal of Public Hygiene.
American Journal of Medical Sciences.
Journal of the American Medical Association.
Engineering News.
American Academy of Medicine.

348 THE HEALTH OF THE CITY

Technology Quarterly.

Science.

Municipal Affairs.

BACTERIOLOGY

Conn, The Story of Germ Life. D. Appleton and Co. 1897.

Conn, Bacteria, Yeasts and Molds in the Home. Ginn and Co. 1903.

Fischer, Structure and Function of Bacteria. Trans. Coppen Jones. Clarendon Press, Oxford. 1900.

Frankland, Mrs. Percy, Bacteria in Daily Life. Longmans, Green and Co. 1903.

Lipman, Bacteria in Relation to Country Life. Macmillan Co. 1908.

Muir and Ritchie, Manual of Bacteriology. Macmillan Co. 1907.

Prescott and Winslow, Water Bacteriology. Wiley and Sons. 1908.

Report of the Merchants Assoc. of N. Y., Typhoid Fever. March, 1908.

Whipple, Typhoid Fever. Wiley and Sons. 1908.

Winslow, Systematic Relationship of the Coccæ. Wiley and Sons. 1908.

HYGIENE AND SANITATION

Abbott, Hygiene of Transmissible Diseases. W. B. Saunders Co. 1899.

- Baker, Municipal Engineering and Sanitation. Macmillan Co. 1906.
- Bergey, The Principles of Hygiene. W. B. Saunders Co. 1909.
- Chapin, Municipal Sanitation in the United States. Snow. Providence, 1906.
- Fisher, Bulletin of the Committee of One Hundred on the Conservation of Vital Resources. Title Guarantee and Trust Co. New York, 1909.
- Fitz, Physiology and Hygiene. Henry Holt and Co. 1908.
- Gerhard, Sanitation of Public Buildings. Wiley and Sons. 1907.
- Harrington, Practical Hygiene. Lea Bros. and Co. 1902.
- Hough and Sedgwick, The Human Mechanism. Ginn and Co. 1906.
- Pyle, Personal Hygiene. W. B. Saunders Co. 1900.
- Sedgwick, Principles of Sanitary Science. Macmillan Co. 1902.
- Shaw, School Hygiene. Macmillan Co. 1901.
- Sternberg, Infection and Immunity. Putnam. 1903.
- Vernon-Harcourt, Sanitary Engineering. Longmans, Green and Co. 1907.

AIR

- Booth and Kershaw, Smoke Prevention and Fuel Economy. Henley. 1905.

350 THE HEALTH OF THE CITY

Cohen, *The Air of Towns*. Government Printing Office. 1896.

De Varigny, *Air and Life*. Government Printing Office. 1896.

Nicholson, *Practical Smoke Prevention*. Sanitary Publishing Co. London, 1902.

Prudden, *Dust and its Dangers*. G. P. Putnam and Sons. 1907.

Randall and Weeks, *The Smokeless Combustion of Coal in Boiler Plants*. U. S. G. S. No. 23. 1909.

Richards and Woodman, *Air, Water, and Food*. Wiley and Sons. 1906.

Russell, *The Atmosphere in Relation to Human Life and Health*. Smithsonian Institute. Washington, 1896.

Soper, *Air and Ventilation of Subways*. Wiley and Sons. 1908.

Soper, *Modern Methods of Street-Cleaning*. Engineering News Pub. Co. 1909.

Tyndall, *Essays on the Floating Matter in the Air in Relation to Putrefaction and Infection*. Longmans, Green and Co. 1883.

MILK

Belcher, *Clean Milk*. Hardy Publishing Co. 1903.

Bulletin No. 56 of the Hygiene Laboratory, Department of Treasury. *Milk and its Relation to the Public Health*. 1909.

- Chapin, Theory and Practice of Infant Feeding. Wm. Wood and Co. 1909.
- Conn, Practical Dairy Bacteriology. Orange Judd Co. 1907.
- Conn, Bacteria in Milk and its Products. P. Blakiston's Son and Co. 1903.
- Jensen, Essentials of Milk Hygiene. Trans. Pearson. J. B. Lippincott. 1909.
- Kober, Milk in Relation to the Public Health. Senate Document. 1902.
- Rotch, Pediatrics. J. B. Lippincott. 1909.
- Spargo, The Common Sense of the Milk Question. Macmillan Co. 1908.
- Wardwell, Practical Milk Inspection by a District Medical Society. Annals of Gynecology and Pediatrics, vol. xxi. 1908.
- Wardwell, Some Things that a Physician ought to know about Milk. Annals of Gynecology and Pediatrics, vol. xxi. 1908.

FOOD

- Blyth, Foods, their Composition and Analysis. Charles Griffin and Co. 1903.
- Chittenden, Physiological Economy in Nutrition. Stokes. 1904.
- Chittenden, The Nutrition of Man. Stokes. 1907.
- Fletcher, The A. B.-Z. of Our Own Nutrition. Stokes. 1906.
- Friedenwald and Ruhräh, Diet in Health and Disease. Saunders Co. 1909.

352 THE HEALTH OF THE CITY

Hutchison, Food and the Principles of Dietetics.
Wm. Wood and Co. 1903.

Langworthy, The Nutrition Investigations of the
Office of Experiment Stations and their Results.
Annual Report of the Office of Experiment Sta-
tions. 1906.

Leach, Food Inspection and Analysis. Wiley and
Sons. 1907.

Richards, The Cost of Food: A Study in Dietaries.
Wiley and Sons. 1901.

Richards, Food Materials and their Adulteration.
Whitcomb and Barrows. 1886.

Richards, Dietary Computer. Wiley and Sons.
1902.

Richards, Dietary Studies. Wiley and Sons. 1903.

Sunderland (Editor), System of Diet and Dieta-
ries. Oxford Medical Publications. 1908.

Thompson, Practical Dietetics with Special Refer-
ence to Diet in Disease. D. Appleton and Co.
1899.

Townshend, The Relation of Food to Health. Witt
Publishing Co. St. Louis, 1897.

Wiley, Foods and their Adulteration. P. Blakis-
ton's Son and Co. 1907.

WATER

Frankland, G. and P., Micro-Organisms in Water.
Longmans, Green and Co. 1894.

Gerhard, Water Supply, Sewerage and Plumbing of
Modern City Buildings. Wiley and Sons. 1910.

- Gerhard, Sanitation, Water Supply and Sewage Disposal of Country Houses. J. B. Lippincott. 1909.
- Hazen, Clean Water and How to Get It. Wiley and Sons. 1907.
- Hazen, Filtration of Public Water Supplies. Wiley and Sons. 1903.
- Mason, Water Supply. Wiley and Sons. 1896.
- Whipple, Value of Pure Water. Wiley and Sons. 1907.

SEWAGE

- Baker, Sewerage and Sewage Purification. Van Nostrand. 1896.
- Cosgrove, Sewage Purification and Disposal. Standard Sanitary Manufacturing Co., Pittsburg. 1909.
- Dunbar, Principles of Sewage Treatment. Trans. Calvert. Charles Griffin and Co. London, 1908.
- Fowler, Some Principles underlying the Design of Small Sewage Installations. Wiley and Sons. 1907.
- Gerhard, The Disposal of Household Wastes. Van Nostrand Co. 1904.
- Kinnicutt, Winslow and Pratt, Sewage Disposal. Wiley and Sons. (In press.)
- Raikes, The Design, Construction and Maintenance of Sewage Disposal Works. Constable, 1908.
- Winslow and Phelps, Investigations on the Purifi-

352 THE HEALTH OF THE CITY

- Hutchison, Food and the Principles of Dietetics. Wm. Wood and Co. 1903.
- Langworthy, The Nutrition Investigations of the Office of Experiment Stations and their Results. Annual Report of the Office of Experiment Stations. 1906.
- Leach, Food Inspection and Analysis. Wiley and Sons. 1907.
- Richards, The Cost of Food: A Study in Dietaries. Wiley and Sons. 1901.
- Richards, Food Materials and their Adulteration. Whitcomb and Barrows. 1886.
- Richards, Dietary Computer. Wiley and Sons. 1902.
- Richards, Dietary Studies. Wiley and Sons. 1903.
- Sunderland (Editor), System of Diet and Dietaries. Oxford Medical Publications. 1908.
- Thompson, Practical Dietetics with Special Reference to Diet in Disease. D. Appleton and Co. 1899.
- Townshend, The Relation of Food to Health. Witt Publishing Co. St. Louis, 1897.
- Wiley, Foods and their Adulteration. P. Blakiston's Son and Co. 1907.

WATER

- Frankland, G. and P., Micro-Organisms in Water. Longmans, Green and Co. 1894.
- Gerhard, Water Supply, Sewerage and Plumbing of Modern City Buildings. Wiley and Sons. 1910.

- Gerhard, Sanitation, Water Supply and Sewage Disposal of Country Houses. J. B. Lippincott. 1909.
- Hazen, Clean Water and How to Get It. Wiley and Sons. 1907.
- Hazen, Filtration of Public Water Supplies. Wiley and Sons. 1903.
- Mason, Water Supply. Wiley and Sons. 1896.
- Whipple, Value of Pure Water. Wiley and Sons. 1907.

SEWAGE

- Baker, Sewerage and Sewage Purification. Van Nostrand. 1896.
- Cosgrove, Sewage Purification and Disposal. Standard Sanitary Manufacturing Co., Pittsburg. 1909.
- Dunbar, Principles of Sewage Treatment. Trans. Calvert. Charles Griffin and Co. London, 1908.
- Fowler, Some Principles underlying the Design of Small Sewage Installations. Wiley and Sons. 1907.
- Gerhard, The Disposal of Household Wastes. Van Nostrand Co. 1904.
- Kinnicutt, Winslow and Pratt, Sewage Disposal. Wiley and Sons. (In press.)
- Raikes, The Design, Construction and Maintenance of Sewage Disposal Works. Constable, 1908.
- Winslow and Phelps, Investigations on the Purifi-

cation of Boston Sewage. Geological Survey, 1906.

ICE

Character and Quality of the Ice Supply of London. *Lancet*, vol. lxxi, 1893, ii.

Hill, An Investigation of the Boston Ice Supply. *Boston Medical and Surgical Journal*, vol. cxlv, pages 557-561.

Leidy, Organisms in Ice. *Proc. Acad. Nat. Sci. Philadelphia*, 1884.

Nichols, Report on an Outbreak of Intestinal Disorder attributable to the Contamination of Drinking Water by Means of Impure Ice. *Seventh Annual Report, State Board of Health, Massachusetts*. 1876.

Park, Duration of Life of Typhoid Bacilli, derived from Twenty Different Sources, in Ice. *Journal of the Boston Society of Medical Sciences*, vol. v.

Pengra, Purification of Water by Freezing. *Twelfth Annual Report State Board of Health, Michigan*. 1884.

Prudden, On Bacteria in Ice and their Relations to Disease, with Special Reference to the Ice Supply of New York City. *The Medical Record*, March 26 and April 2, 1887.

Ravenel, The Resistance of Bacteria to Cold. *Medical News*, Philadelphia, June 10, 1899.

Report upon the Pollution of Ice Supplies. *Twenty-first Annual Report, State Board of Health, Massachusetts*. 1889.

Sedgwick and Winslow, Experiments upon the Effect of Freezing and other Low Temperatures upon the Viability of the Bacillus of Typhoid Fever, with Considerations Regarding Ice as a Vehicle of Infectious Disease. Memoirs of the American Academy of Arts and Sciences, vol. xii, No. 5. 1902.

PLUMBING

Andrewes, Reports on the Micro-Organisms Present in Sewer Air and in the Air of Drains. Local Government Board. Thirty-sixth and Thirty-seventh Annual Reports, 1906-07, 1907-08.

Carnelley and Haldane, Air of Sewers. Royal Society of London, vol. xlii. 1887.

Cosgrove, Principles and Practice of Plumbing. Standard Sanitary Manufacturing Co. Pittsburgh, 1906.

D'Alessi, Translation of account of his Experiment. Journal of Sanitary Institute, vol. xvi.

Frankland, Transport of Solid and Liquid Particles in Sewer Gas. Royal Society of London, vol. xxv. 1876-77.

Horrocks, Specific Bacteria derived from Sewage which may be Present in the Air of Ventilator Pipes, Drains, Inspection Chambers and Sewers. Royal Society, February 7, 1907, vol. lxxix, No. B, 531.

356 THE HEALTH OF THE CITY

- London County Council, Report of Sewer Air Investigation, 1893, No. 126, and 1898, No. 189.
- Pumpelly, Relation of Soils to Health. National Board of Health Report, 1881.
- Reports of the Sanitary Committee, National Association of Master Plumbers of United States, 1907-08-09.
- Roechling, Sewer Gas and its Influence on Health. Biggs and Co. London, 1898.

NOISE

- Beard, Physiological Effects of Noise. Century Magazine, 1908.
- First, Second, and Third Annual Reports of the Society for the Suppression of Unnecessary Noise. New York City, 1908-09-10.
- Morse, The Steam Whistle a Menace to Public Health. 1905. Read before the Massachusetts Association Boards of Health. Published privately.
- Rice, Hoodlumism in Holiday Observance. Forum, 1909.
- Rice, An Effort to Suppress Noise. Forum, 1906.
- Rice, Our Most Abused Sense, the Sense of Hearing. Forum, 1907.
- Rice, The Children's Hospital Branch of the Society for the Suppression of Unnecessary Noise. Forum, 1908.
- Rice, Our Barbarous Fourth. Century Magazine, 1908.

HOUSING

- Alden and Hayward, Housing. Headley Bros. London, 1907.
- DeForest and Veiller, The Tenement House Problem, vols. i and ii. Macmillan Co. 1903.
- Garden Suburbs, Villages, and Homes. Garden City Press, 1906.
- Harris, The Garden City Movement. Garden City Press, 1905.
- Horsfall, Improvement of Dwellings. University Press, Manchester, England. 1905.
- Hunter, Tenement Conditions in Chicago. City Homes Association. Chicago, 1901.
- Marr, Housing Conditions in Manchester and Salford. Sherratt and Hughes. 1904.
- Merchants Association of New York. Passenger Transportation Service in the City of New York. 1903.
- Nettlefold, Practical Housing. Garden City Press, 1908.
- Nettlefold, A Housing Policy. Cornish Bros. Birmingham, 1905.
- Report of the Housing Committee of Birmingham. Published by the City. 1906.
- Report of the Royal Commission, Housing of Working Classes. British Blue Book, 1885.
- Reynolds, Housing of the Poor in American Cities. Published in the publications of the American Economic Association, vol. viii, Nos. 2, 3.
- Special Report on the Housing of Working Classes Amendment Act. British Blue Book, 1906.

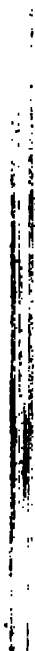
- Sykes, Public Health and Housing. P. S. King and Son. 1901.
- Thompson, Housing Handbook. H. R. Aldrich. London, 1903.
- Weber, The Growth of Cities in the Nineteenth Century. Macmillan Co. 1899.

TUBERCULOSIS

List obtained from the National Association for the Study and Prevention of Tuberculosis:—

- Flick, Tuberculosis: A Curable and Preventable Disease. J. C. Winston Co. 1910.
- Flick, The Crusade against Tuberculosis: Consumption a Curable and Preventable Disease: What a Layman should know about it. McKay. 1903.
- Knopf, Tuberculosis as a Disease of the Masses and how to Combat it. The Survey. New York, 1908.
- Knopf, Tuberculosis: A Preventable and Curable Disease: Modern Methods for the Solution of the Tuberculosis Problem. Moffat, Yard and Co. 1909.
- Otis, The Great White Plague — Tuberculosis. T. Y. Crowell and Co. 1909.

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